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FINAL SAMPLING AND ANALYSIS PLAN FOR TPH DELINEATION AT CED AREA SITE 03  
AND ADDITIONAL GROUNDWATER SAMPLING AT SITES 02 AND 03 AND THE DRUM  
REMOVAL AREA FORMER NCBC DAVISVILLE RI  
08/01/2014  
NAVFAC MID ATLANTIC

**Final  
Sampling and Analysis Plan  
for  
TPH Delineation at CED Area Site 03 and  
Additional Groundwater Sampling at  
Sites 02 and 03 and the Drum Removal Area**

**Former Naval Construction  
Battalion Center Davisville**  
North Kingstown, Rhode Island



**Naval Facilities Engineering Command  
Mid-Atlantic**

**Contract Number N62470-08-D-1001**

**Contract Task Order WE01**

August 2014

## Title and Approval Page

(UFP-QAPP Manual Section 2.1)

**FINAL**  
**SAMPLING AND ANALYSIS PLAN**  
**(Field Sampling Plan and Quality Assurance Project Plan)**  
**August 2014**

**TPH Delineation at CED Area Site 03 and  
Additional Groundwater Sampling at Sites 02 and 03 and the Drum Removal Area**


**Former Naval Construction Battalion Center Davisville  
North Kingstown, Rhode Island**

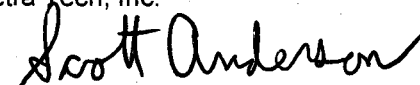
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**Prepared under:**  
**Comprehensive Long-Term Environmental Action Navy**  
**Contract No. N62470-08-D-1001**  
**Contract Task Order WE01**

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## Title and Approval Page

(UFP-QAPP Manual Section 2.1)

**DRAFT**  
**SAMPLING AND ANALYSIS PLAN**  
**(Field Sampling Plan and Quality Assurance Project Plan)**  
**May 2014**

**TPH Delineation at CED Area Site 03 and  
Additional Groundwater Sampling at Sites 02 and 03 and the Drum Removal Area**


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Christine Williams, USEPA Region I

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Richard Gottlieb, RIDEM

Project-Specific Sampling and Analysis Plan  
Site Name: CED Area Site 03, NCBC Davisville  
Project Name: TPH Delineation and Groundwater Sampling  
Site Location: North Kingstown, Rhode Island

Title: Sampling and Analysis Plan  
Revision Number: 0  
Revision Date: April 2014

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## EXECUTIVE SUMMARY

Tetra Tech, Inc., has prepared this Sampling and Analysis Plan (SAP) that encompasses Field Sampling Plan (FSP) and Quality Assurance Project Plan (QAPP) requirements for an investigation to provide data necessary to refine estimates of contaminated soil at Construction Equipment Department (CED) Area at the Former Naval Construction Battalion Center (NCBC) Davisville Facility in North Kingstown, Rhode Island, under Contract Task Order (CTO) WE01, Contract N62470-08-D-1001, Comprehensive Long-Term Environmental Action Navy (CLEAN). Additionally, the SAP provides the requirements for sampling 17 existing monitoring wells and six new monitoring wells within the CED Area. The existing monitoring wells are being sampled to further investigate the potential for chemical migration from soil to groundwater and the potential for vapor migration from groundwater to the indoor air of a building hypothetically constructed atop Sites 02/03. The new monitoring wells are being sampled to investigate the potential for groundwater contamination at the Drum Removal Area.

For clarification, the Navy's normalized database of environmental liabilities identifies "CED Area Site 03" as all future liabilities for two sites (Sites 02 and 03) and two study areas (Study Areas 01 and 04), and the recently discovered and investigated Drum Removal Area in the northwestern corner of the CED Area. Therefore, CED Area Site 03 (i.e., the area encompassing Sites 02/03, Study Areas 01/04, and the Drum Removal Area) will be referred to as the CED Area throughout the remainder of the SAP to avoid confusion when specifically referencing Site 03 *within* the "CED Area Site 03".

This SAP was generated for and complies with applicable United States Department of the Navy, United States Environmental Protection Agency (USEPA) Region I, and Rhode Island Department of Environmental Management (RIDEM) requirements, regulations, guidance, and technical standards. This includes Department of Defense (DoD), Department of Energy (DOE), and USEPA Intergovernmental Data Quality Task Force (IDQTF) environmental requirements regarding federal facilities.

This SAP outlines the organization, project management, objectives, planned activities, measurement, data acquisition, assessment, oversight, and data review procedures associated with the planned investigations at CED Area. Protocols for sample collection, handling and storage, chain of custody, laboratory and field analyses, data validation, and reporting are also addressed in this SAP.

**SAP Worksheets**

**Page No.**

Title and Approval Page .....	1
EXECUTIVE SUMMARY .....	3
Acronyms and Abbreviations .....	6
1.0 -- Project Organizational Chart .....	10
2.0 -- Communication Pathways .....	11
3.0 -- Project Planning Session Participants Sheet .....	14
4.0 -- Conceptual Site Model.....	16
4.1 SITE DESCRIPTIONS AND HISTORY .....	16
4.2 SUMMARY OF HISTORICAL TPH RESULTS AT SITE 03 .....	18
4.3 SUMMARY OF HISTORICAL SOIL RESULTS EXCEEDING LEACHABILITY CRITERIA AND HISTORICAL SHALLOW GROUNDWATER RESULTS .....	18
4.4 POTENTIAL CONTAMINANT MIGRATION PATHWAYS AND EXPOSURE POTENTIAL ...	19
5.0 -- Project Quality Objectives/Systematic Planning Process Statements .....	20
5.1 PROBLEM STATEMENTS .....	20
5.2 DATA NEEDS.....	21
5.3 STUDY BOUNDARIES.....	23
5.4 ANALYTIC APPROACH.....	24
5.5 PERFORMANCE CRITERIA.....	26
5.6 SAMPLING DESIGN AND RATIONALE .....	26
6.0 -- Field Quality Control Samples .....	27
7.0 -- Sampling Design and Rationale .....	28
7.1 SOIL BORINGS AT SITE 03 .....	28
7.2 GROUNDWATER SAMPLES.....	29
8.0 -- Field Project Implementation (Field Project Instructions) .....	34
8.1 FIELD PROJECT TASKS.....	34
8.2 FIELD SOPs REFERENCE TABLE .....	44
9.0 -- Reference Limits and Evaluation Tables .....	53
10.0 -- Analytical SOP Reference Table .....	65
11.0 -- Laboratory QC Samples Tables.....	67
12.0 -- Data Verification and Validation (Steps I and IIa/IIb) Process Table .....	82
12.1 VALIDATION SUMMARY .....	86
REFERENCES.....	87

## LIST OF TABLES

7-1	Wells Identified for Additional Sampling.....	32
8-1	Sample Details Table .....	46
8-2	Analytical SOP Requirements Table.....	50
8-3	Field Quality Control Sample Summary Table.....	52

## LIST OF FIGURES

4-1	Site Location Map
4-2	Former Construction Equipment Department Area
4-3	Historical TPH Concentrations and Proposed Sampling Locations at Site 03
4-4	Proposed Monitoring Well Sampling Locations
4-5	Conceptual Site Model

## LIST OF APPENDICES

A	– BCT Teleconference Notes - December 12, 2013
B	– BCT Teleconference Notes - November 12, 2013
C	– Time-Critical Removal Action Memorandum
D	– Site-Specific Field Standard Operating Procedures
E	– Laboratory DoD ELAP Accreditation
F	– Selection of Project Screening Levels (Worksheet #9 Backup)

## ACRONYMS AND ABBREVIATIONS

°C	Degree Celsius
%R	Percent recovery
AES	Atomic emission spectroscopy
ARAR	Applicable or Relevant and Appropriate Requirement
BCT	BRAC Cleanup Team
BEC	BRAC Environmental Coordinator
bgs	Below ground surface
BRAC	Base Realignment and Closure
CCB	Continuing calibration blank
CCV	Continuing calibration verification
CED	Construction Equipment Department
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLEAN	Comprehensive Long-Term Environmental Action Navy
COC	Chemical of concern
COPC	Chemical of potential concern
CSM	Conceptual site model
CTO	Contract Task Order
CVAA	Cold vapor atomic absorption
DEC	Direct Exposure Criterion
DI	Deionized
DL	Detection Limit
DO	Dissolved oxygen
DoD	Department of Defense
DOE	Department of Energy
DPT	Direct-push technology
DQI	Data Quality Indicator
DQO	Data Quality Objective
DRO	Diesel-Range Organics
DVM	Data Validation Manager
EDD	Electronic Data Deliverable
ELAP	Environmental Laboratory Accreditation Program
EPC	Exposure point concentration
FFS	Focused Feasibility Study
FOL	Field Operations Leader

FSP	Field Sampling Plan
FTMR	Field Task Modification Request
g	Gram
GC/ECD	Gas chromatography/electron capture detector
GC/FID	Gas chromatography/flame ionization detector
GC/MS	Gas chromatography/mass spectrometry
GPS	Global positioning system
GRO	Gasoline-Range Organics
HASP	Health and Safety Plan
HHRA	Human health risk assessment
HI	Hazard index
HSM	Health and Safety Manager
ICB	Initial calibration blank
ICP	Inductively Coupled Plasma
ICP/MS	Inductively Coupled Plasma/Mass Spectroscopy
ICS	Interference Check Solution
ICV	Initial calibration verification
IDQTF	Intergovernmental Data Quality Task Force
IDW	Investigation-derived waste
IS	Internal Standard
L	Liter
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
LOD	Limit of Detection
LOQ	Limit of quantitation
MCL	Maximum Contaminant Level
mg/kg	Milligram per kilogram
ml	Milliliter
MPC	Measurement Performance Criterion
MS	Matrix spike
MSD	Matrix spike duplicate
MTBE	Methyl tert-butyl ether
NA	Not applicable
NAD	North American Datum
NAVFAC	Naval Facilities Engineering Command
Navy	U. S. Department of the Navy
NCBC	Naval Construction Battalion Center

NEDD	NIRIS Electronic Data Deliverable
NIRIS	Naval Installation Restoration Information Solution
NGVD	National Geodetic Vertical Datum
oz	Ounce
ORP	Oxidation-reduction potential
PAH	Polycyclic aromatic hydrocarbon
PAL	Project action limit
PCB	Polychlorinated Biphenyl
PID	Photoionization Detector
PM	Project Manager
PMO	Project Management Office
PPE	Personal protective equipment
PQLG	Project quantitation limit goal
PSL	Project screening level
QA	Quality Assurance
QAM	Quality Assurance Manager
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	Quality Control
QDC	Quonset Development Corporation
QSM	Quality Systems Manual
RI	Remedial Investigation
RIDEM	Rhode Island Department of Environmental Management
RPD	Relative Percent Difference
RPM	Remedial Project Manager
RSD	Relative Standard Deviation
RSL	Regional Screening Level
RT	Retention Time
SDWA	Safe Drinking Water Act
Spectrum	Spectrum Analytical, Inc.
SAP	Sampling and Analysis Plan
SIM	Selected Ion Monitoring
SOP	Standard Operating Procedure
SQL	Structured Query Language
SSL	Soil Screening Level
SSO	Site Safety Officer
SVOC	Semivolatile organic compound



TAL	Target Analyte List
TBD	To be determined
TCL	Target Compound List
TPH	Total Petroleum Hydrocarbons
T-RSL	Tapwater Regional Screening Level
UCL	Upper confidence limit
µg/kg	Microgram per kilogram
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
UST	Underground storage tank
VISL	Vapor Intrusion Screening Level
VOC	Volatile organic compound

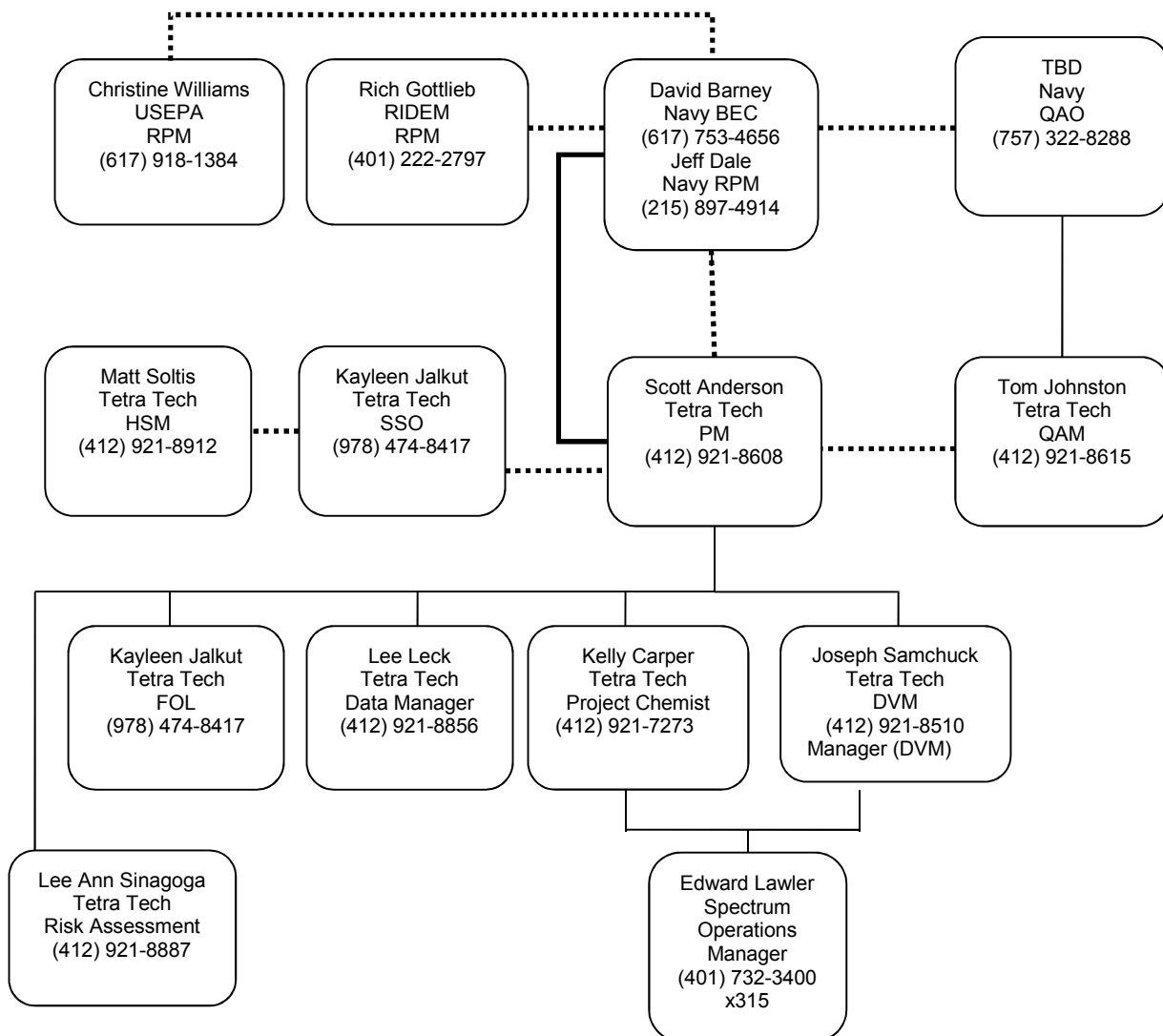
## 1.0 -- Project Organizational Chart

(UFP-QAPP Manual Section 2.4.1 – Worksheet #5)

Lines of Authority



..... Lines of Communication



BEC – BRAC Environmental Coordinator  
 DVM – Data Validation Manager  
 FOL – Field Operations Leader  
 HSM – Health and Safety Manager  
 PM – Project Manager  
 QAM – Quality Assurance Manager  
 RIDEM – Rhode Island Department of Environmental Management  
 RPM – Remedial Project Manager  
 SSO – Site Safety Officer  
 TBD – To Be Determined  
 USEPA – United States Environmental Protection Agency

## 2.0 -- Communication Pathways

(UFP-QAPP Manual Section 2.4.2 – Worksheet #6)

The communication pathways for this Sampling and Analysis Plan (SAP) are shown below.

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
Regulatory agency interface	RIDEM RPM USEPA RPM Navy RPM	Richard Gottlieb Christine Williams Jeff Dale	401-222-2797 617- 918-1384 215-897-4914	The Navy RPM will contact the regulatory agency via phone and/or e-mail within 24 hours of recognizing the issue whenever issues arise.
Field progress reports	Tetra Tech FOL Tetra Tech PM	Kayleen Jalkut Scott Anderson	978-474-8417 412-921-8608	The Tetra Tech FOL will contact the Tetra Tech PM on a daily basis via phone and every 1-2 days via e-mail to summarize progress.
Gaining site access	Tetra Tech FOL Navy BEC	Kayleen Jalkut David Barney	978-474-8417 617-753-4656	The Tetra Tech FOL will contact the Davisville BEC verbally or via e-mail at least 3 days prior to commencement of field work to arrange for access to the site for all field personnel.
Obtaining utility clearances	Tetra Tech FOL	Kayleen Jalkut	978-474-8417	The Tetra Tech FOL shall contact DigSafe via telephone at least 5 days prior to commencement of field work to complete a utility clearance ticket for the areas under investigation. QDC will be notified via DigSafe, though can also be contacted directly to confirm work area as well.
Stop work due to safety issues	Tetra Tech FOL/SSO Tetra Tech PM Tetra Tech HSM Navy RPM BEC	Kayleen Jalkut Scott Anderson Matt Soltis Jeff Dale David Barney	978-474-8417 412-921-8608 412-921-8612 215-897-4914 617-753-4656	If Tetra Tech is the responsible party for a stop-work command, the Tetra Tech FOL will inform on-site personnel, subcontractor(s), the Davisville BEC, and the identified Project Team members within 1 hour (verbally or by e-mail).  If a subcontractor is the responsible party, the subcontractor PM must inform the Tetra Tech FOL within 15 minutes, and the Tetra Tech FOL will then follow the procedure listed above.

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
SAP changes prior to field/ laboratory work	Tetra Tech FOL/SSO Tetra Tech PM Navy RPM BEC	Kayleen Jalkut Scott Anderson Jeff Dale David Barney	978-474-8417 412-921-8608 215-897-4914 617-753-4656	The Tetra Tech PM will document the proposed changes via a Field Task Modification Request (FTMR) form within 5 days and send the Navy RPM a concurrence letter within 7 days of identifying the need for change. SAP amendments will be submitted by the Tetra Tech PM to the Navy RPM and BEC for review and approval. The Tetra Tech PM will send scope changes to the Project Team via e-mail within 1 business day.
SAP changes in the field	Tetra Tech FOL/SSO Tetra Tech PM Navy RPM BEC	Kayleen Jalkut Scott Anderson Jeff Dale David Barney	978-474-8417 412-921-8608 215-897-4914 617-753-4656	The Tetra Tech FOL will verbally inform the Tetra Tech PM on the day that the issue is discovered. The Tetra Tech PM will inform the Navy RPM and BEC (verbally or via e-mail) within 1 business day of discovery. The Navy RPM will issue a scope change (verbally or via e-mail), if warranted. The scope change is to be implemented before further work is executed. The Tetra Tech PM will document the change via an FTMR form within 2 days of identifying the need for change and will obtain required approvals within 5 days of initiating the form.
Field corrective actions	Tetra Tech PM Tetra Tech QAM Navy RPM	Scott Anderson Tom Johnston Jeff Dale	412-921-8608 412-921-8615 215-897-4914	The Tetra Tech QAM will notify the Tetra Tech PM verbally or by e-mail within 1 business day that the corrective action has been completed. The Tetra Tech PM will then notify the Navy RPM (verbally or by e-mail) within 1 business day.

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
Analytical data quality issues	Spectrum PM Tetra Tech Project Chemist Tetra Tech DVM Tetra Tech PM Navy RPM	Ed Lawler Kelly Carper  Joseph Samchuck Scott Anderson Jeff Dale	401-732-3400 412-921-7273  412-921-8510 412-921-8608 215-897-4914	<p>The Laboratory PM will notify (verbally or via e-mail) the Tetra Tech Project Chemist within 1 business day of when an issue related to laboratory data is discovered.</p> <p>The Tetra Tech Project Chemist will notify (verbally or via e-mail) the DVM and Tetra Tech PM within 1 business day.</p> <p>The Tetra Tech DVM or Project Chemist will notify the Tetra Tech PM verbally or via e-mail within 48 hours of validation completion that a non-routine and significant laboratory quality deficiency has been detected that could affect this project and/or other projects. The Tetra Tech PM will then verbally advise the Navy RPM within 24 hours of notification from the Tetra Tech Project Chemist or DVM. The Navy RPM will take corrective action appropriate for the identified deficiency. Examples of significant laboratory deficiencies include data reported that have a corresponding failed tune or initial calibration verification. Corrective actions may include a consult with the Navy Chemist.</p>

### 3.0 -- Project Planning Session Participants Sheet

(UFP-QAPP Manual Section 2.5.1 – Worksheet #9)

<b>Project Name:</b> <u>Total Petroleum Hydrocarbon (TPH) Delineation and Additional Groundwater Sampling</u>  <b>Projected Date(s) of Sampling:</b> <u>Summer 2014</u>  <b>Project Manager:</b> <u>Scott Anderson</u>		<b>Site Name:</b> <u>Construction Equipment Department (CED) Area Site 03 – Solvent Disposal Area</u>  <b>Site Location:</b> <u>North Kingstown, Rhode Island</u>			
<b>Date of Session (TPH Delineation):</b> February 28, 2013 <b>TPH Scoping Session Purpose:</b> Data Quality Objective (DQO) Scoping Meeting <b>Base Realignment and Closure (BRAC) Cleanup Team (BCT) Teleconference Dates:</b> November 12, 2013; December 12, 2013; January 15, 2014					
Name	Title	Affiliation	Phone #	E-Mail Address	Project Role
LeeAnn Sinagoga	Risk Assessor/Manager	Tetra Tech	412-921-8616	leeann.sinagoga@tetrattech.com	Management/Oversight
Tom Johnston	DQO Facilitator	Tetra Tech	412-921-8615	tom.johnston@tetrattech.com	DQO Facilitator
Leigh Ciofani	Environmental Scientist	Tetra Tech	412-921-8616	leigh.ciofani@tetrattech.com	Technical Support

**Background for TPH Soil Sampling:** Site 03 within the CED Area is an unmarked previously paved lot located west of former Building 224 and Sayers Street and south of Battalion Boulevard. From 1955 to the late 1970s, the disposal of paint thinners and unidentified solvents onto the ground is thought to have occurred in the area bordering Sayers Street, although the exact locations and limits of contaminant disposal are uncertain. It is estimated that 3,000 gallons of solvents were disposed of at the site at a rate of 10 gallons per month. Heavy equipment storage also took place on a portion of Site 03.

Comments/Decisions: Discussed Site 03 historical use and available data. Discussed the steps for implementing soil delineation sampling for TPH.

Action Items: Prepare the draft Tier II SAP.

Consensus Decisions: The meeting participants developed the overall strategy for soil sampling to delineate TPH concentrations at Site 03. Consensus decisions included the following:

- Surface and subsurface soil sampling will be conducted to refine the delineation of areas of soil impacted with TPH.

- Surface soil samples will be collected from 0 to 2 feet below ground surface (bgs) at all soil boring locations (selected based on historical TPH sampling locations and a 50- by 50-foot sampling grid). Subsurface soil samples from 2 to 4 feet bgs, 4 to 6 feet bgs, and 6 to 10 feet bgs (the approximate depth to the top of the water table) will also be collected at all boring locations.
- All samples will be sent to the laboratory; however, the laboratory will hold samples collected from 4 to 6 feet bgs and 6 to 10 feet bgs until further instruction from the Navy/Tetra Tech. The Navy/Tetra Tech will select samples collected from intervals deeper than 4 feet bgs for laboratory analysis based on field observations, field screening results, and raw data for samples from 0 to 2 feet bgs and 2 to 4 bgs.

**Background for Additional Groundwater Sampling:** The groundwater sampling proposed in this SAP was discussed (most recently) during several of the Naval Construction Battalion Center (NCBC) Davisville BCT teleconferences occurring in 2013 and January 2014. The BCT teleconference notes (and discussions/agreements contained therein) regarding the additional groundwater sampling are included as [Appendix A](#). In overview, the BCT agreed to the following:

- Three new well clusters will be installed at the CED Drum Removal Area. A maximum of three wells will be installed at each cluster location.
- Seventeen existing shallow-zone monitoring wells will be sampled to further investigate the potential for chemical migration from soil to groundwater and the potential for vapor intrusion as a consequence of volatile organic contamination in shallow-zone groundwater at the CED Area Site 03. Samples from the existing monitoring wells will be analyzed for volatile organic compounds (VOCs), TPH, naphthalene, and unfiltered and filtered metals.
- Samples from the new CED Drum Removal Area will be analyzed for VOCs, TPH, semivolatile organic compounds (SVOCs), pesticides/polychlorinated biphenyls (PCBs), and unfiltered/filtered metals.

The DQOs for the new monitoring wells at the CED Drum Removal Area (i.e., rationale for locations/screened intervals/target analyte lists) are provided under separate cover (see [Appendix B](#)). This SAP only addresses the sampling and analytical requirements for the proposed sampling of these new monitoring wells.

## 4.0 -- Conceptual Site Model

([UFP-QAPP Manual Section 2.5.2 – Worksheet #10](#))

The Former NCBC Davisville was originally composed of three areas, Main Center (referred to as Zones 1 through 4), West Davisville Storage Area, and Camp Fogarty ([Figure 4-1](#)). CED Area Site 03 (i.e., the area encompassing Sites 02/03, Study Areas 01/04, and the Drum Removal Area) is located within Zone 3 and will be referred to as the CED Area throughout the remainder of the SAP to avoid confusion when specifically referencing Site 03 *within* CED Area Site 03. The entire CED Area is currently leased to the Quonset Development Corporation (QDC) under a Lease in Furtherance of Conveyance. This worksheet presents general background information for the following three sub-areas of the CED Area Site 03:

- Site 02 – Former CED Battery Acid Disposal Area
- Site 03 – Solvent Disposal Area
- Drum Removal Area

In overview, Sites 02 and 03 are addressed in this SAP because of residual TPH soil contamination at Site 03 and because of recommendations presented in the Final Human Health Risk Evaluation for the Construction Equipment Department, Former Naval Construction Battalion Center, Davisville (January 2014) to further investigate the potential for contaminant migration from soil to groundwater at these sites. This risk evaluation concluded that risks were acceptable for direct contact (i.e., incidental ingestion, dermal contact, and inhalation) with soil at Sites 02 and 03 (Tetra Tech, 2014). The Drum Removal Area is addressed in this SAP to investigate impacts to groundwater quality in this area associated with potential releases from buried drums recently discovered and removed from this area.

This SAP was generated for and complies with applicable United States Department of the Navy, United States Environmental Protection Agency (USEPA) Region I, and Rhode Island Department of Environmental Management (RIDEM) requirements, regulations, guidance, and technical standards. This includes Department of Defense (DoD), Department of Energy (DOE), and USEPA Intergovernmental Data Quality Task Force (IDQTF) environmental requirements regarding federal facilities.

### 4.1 SITE DESCRIPTIONS AND HISTORY

Site 02, which is approximately 8 acres in size, and Site 03, which is approximately 4.5 acres in size, are located in the southwestern portion of the CED Area. [Figure 4-1](#) shows the location of the CED Area within NCBC Davisville, and [Figure 4-2](#) shows the locations of Sites 02 and 03 within the CED Area.



Site 02 is a previously paved flat area bordered by Warren Street on the south and Sayers Street on the west. The site consisted of a former dry well and leaching field and does not include Building 224. Dilute sulfuric acid (reportedly containing lead) was transported through a floor drain in Building 224 to the dry well and leaching field between 1955 and 1980. It is estimated that 18,000 gallons of dilute sulfuric acid were disposed of into the dry well and leaching field at a rate of 60 gallons per month. In 1996, the Navy conducted a removal action that included removing the well and wastewater and sediments contained within it. The Navy also removed associated piping and lead-contaminated soil, decommissioned three monitoring wells, and cleaned the battery acid rooms in Buildings 224 and A10CT. The removal action included the collection of confirmation samples to ensure that cleanup criteria were met for lead and TPH (EA, 1998). Although cleanup criteria were met for both lead and TPH, lead concentrations that exceed the RIDEM Industrial/Commercial Direct Exposure Criterion [500 parts per million (ppm)] were left at the site. TPH concentrations left at the site do not exceed RIDEM criteria (Foster Wheeler, 1996). A refueling area with underground storage tanks (USTs) was also located in Site 02. The Navy removed the USTs in 1992 (Stone & Webster, 1996). A human health risk assessment (HHRA) for Site 02 soil was included as part of a risk evaluation for the CED Area (Tetra Tech, 2014). The HHRA evaluated exposures to surface and subsurface soil for several potential receptors (construction workers, industrial workers, recreational users, and hypothetical future residents). No chemicals of concern (COCs) were identified for direct contact based on soil data for Site 02. A qualitative evaluation for chemical migration from soil to groundwater was also conducted and concluded that naphthalene in subsurface soil was a potential COC for migration to groundwater (see [Section 4.3](#)).

Site 03 is an unmarked previously paved lot located west of former Building 224 and Sayers Street and south of Battalion Boulevard. From 1955 to the late 1970s, the disposal of paint thinners and unidentified solvents onto the ground is thought to have occurred in the area bordering Sayers Street, although the exact locations and limits of contaminant disposal are uncertain. It is estimated that 3,000 gallons of solvents were disposed of at the site at a rate of 10 gallons per month. Heavy equipment storage also took place on a portion of Site 03 (EA, 1998). An HHRA for Site 03 was conducted as part of a risk evaluation for the CED Area (Tetra Tech, 2014). TPH was selected as a COC for direct contact with soil based on a comparison of concentrations to the RIDEM residential soil criterion. Additionally, TPH was selected as a potential COC for migration from soil to groundwater based on exceedances of RIDEM GA leachability [500 milligrams per kilogram (mg/kg)] and GB leachability (2,500 mg/kg) criteria.

The Drum Removal Area is located in the northwestern corner of the CED Area ([Figure 4-2](#)). In April 2013, the QDC discovered several drums while performing routine grading and bolder removal in this undeveloped portion of the CED Area. In June 2013, a geophysical survey was conducted to assess the extent of buried drums for removal consideration. In October 2013, the Navy removed nine drums from the area, and soil samples were collected from beneath the drums. A copy of the Time-Critical Removal

Action Memorandum and analytical results for the soil samples collected from beneath the drums are included in [Appendix C](#). The soil results from the Time-Critical Removal Action show few exceedances of applicable screening criteria. The depths of the collected soil samples were likely greater than 4 feet below ground surface (below the drums). It is anticipated that a risk assessment will be completed, based on this soils data, in 2014. After the risk assessment has been completed, COCs (if any) will be identified.

#### **4.2 SUMMARY OF HISTORICAL TPH RESULTS AT SITE 03**

TPH data for Site 03 were collected during the first step of a Confirmation Study in 1987 (one surface soil sample) and during Remedial Investigation (RI) sampling events likely conducted in 1993 (10 surface soil samples). Three phases of sampling as part of an RI were conducted at Site 03 between 1989 and 1996 (Tetra Tech, 2014). [Figure 4-3](#) presents historical TPH results. No USEPA criteria are available for TPH; however, RIDEM criteria are available. The RIDEM residential direct exposure criterion (DEC) and GA leachability criterion are both 500 mg/kg, and the RIDEM industrial/commercial DEC and GB leachability criterion are both 2,500 mg/kg. All 11 detected TPH concentrations exceeded the RIDEM residential DEC and GA leachability criterion, and 9 of 11 detected TPH concentrations exceeded the RIDEM industrial/commercial DEC and GB leachability criterion. The locations of the exceedances are scattered across the Site 03 area.

The available historical results indicate that TPH contamination is present in surface soil at Site 03. The source of TPH is expected to be historical contaminant disposal activities conducted at the site and/or potential releases from heavy equipment. The horizontal and vertical extent of contamination exceeding RIDEM criteria is currently unknown.

#### **4.3 SUMMARY OF HISTORICAL SOIL RESULTS EXCEEDING LEACHABILITY CRITERIA AND HISTORICAL SHALLOW GROUNDWATER RESULTS**

As noted previously, TPH concentrations in soil at Site 03 exceed RIDEM GA and GB leachability criteria. Applicable groundwater protection criteria for naphthalene (at Site 02) and metals (e.g., cobalt and iron, at Sites 02 and 03) were also exceeded. In Site 02 shallow subsurface soil, the naphthalene concentration [410 micrograms per kilogram ( $\mu\text{g/kg}$ )] in 1 of 14 samples exceeds the USEPA soil screening level (SSL) of 0.47 mg/kg but is less than the GA leachability criterion (800  $\mu\text{g/kg}$ ). Naphthalene was also detected in 2 of 22 deep subsurface soil samples at Site 02, with a maximum concentration of 620  $\mu\text{g/kg}$ .

Based on the evaluations presented in the Final Human Health Risk Evaluation for the Construction Equipment Department, chemical migration from soil to groundwater at the CED Area is not anticipated to

be a concern when other factors are considered, including frequencies of criteria exceedances and available literature background values for metals in soil (an approved site-specific background soil database is not available for metals in the NCBC Davisville CED area). However, limited historical shallow groundwater data (1995 and 2007) are available for the CED Area wells. [Figure 4-4](#) presents the monitoring wells associated with the CED Area. No historical TPH data are available for groundwater from the CED Area monitoring wells. Naphthalene was only detected in one groundwater sample at a concentration exceeding the current (May 2014) USEPA tap water Regional Screening Level (RSL). Historical groundwater data for metals are not available for wells other than those associated with Study Area 01. Consequently, the currently available groundwater data set is of limited use when determining if contaminant migration from soil to groundwater is occurring.

#### **4.4 POTENTIAL CONTAMINANT MIGRATION PATHWAYS AND EXPOSURE POTENTIAL**

[Figure 4-5](#) identifies the contaminant migration pathways and current and future receptors of concern at the CED Area. Potential human and ecological receptors could be directly exposed to contamination present in site media (e.g., TPH contamination in Site 03 surface soil). Contamination present in soil (e.g., TPH, naphthalene, metals) could also potentially leach from soil to groundwater. VOC contamination in groundwater, if present, could potentially migrate from groundwater through soil and into the indoor air of a building. [Because a VOC groundwater plume underlies soil at the CED Area (see [Section 5.1](#)), it is necessary to understand if the Focused Feasibility Study (FFS) currently being prepared for the CED Area soils needs to address vapor intrusion.]

The current and anticipated future land use of the CED Area is industrial/commercial. The most likely human receptors are industrial and construction workers. Potential exposure pathways for industrial and construction workers include direct contact (i.e., incidental ingestion, dermal contact, and inhalation) with soil. Industrial workers would likely only have potential exposures to surface soil unless potential future construction activities bring subsurface soil to the surface. Construction workers could potentially be exposed to both surface and subsurface soil during work activities (e.g., excavation). Industrial workers could potentially be exposed via inhalation to VOCs migrating from groundwater into indoor air. Construction workers could potentially be exposed to groundwater if present in trenches during excavation activities via incidental ingestion, dermal contact, or inhalation of VOCs. For purposes of completeness, [Figure 4-5](#) also indicates that hypothetical future residents and recreational users could also potentially be exposed to contaminants in environmental media. The exposure pathways are depicted in [Figure 4-5](#) and are similar to those identified for the industrial worker for soil. In addition, the hypothetical future resident could also potentially be exposed to contaminants in groundwater via ingestion, dermal contact, and inhalation (i.e., showering/bathing), and vapor intrusion (indoor air).

## 5.0 -- Project Quality Objectives/Systematic Planning Process Statements

([UFP-QAPP Manual Section 2.6.1 – Worksheet #11](#))

### 5.1 PROBLEM STATEMENTS

**Problem No. 1: Delineation of TPH-Contaminated Soils at Site 03.** The extent of TPH contamination in soil at Site 03 of the CED Area is not sufficiently delineated to estimate volumes of soil that need to be evaluated for remedial alternatives under State of Rhode Island regulations. Therefore, additional data must be collected to refine the Navy's understanding of the nature and extent of TPH contamination at Site 03 and thus to understand the soil volumes potentially requiring remediation.

**Problem No 2: Characterization of Groundwater at Sites 02/03 (in Support of the Evaluation of Leaching Potential)** The Final Human Health Risk Evaluation for the Construction Equipment Department (Tetra Tech, 2014) identified possible soil COCs for groundwater protection (TPH, naphthalene, and possibly select metals). Specifically, the report concluded that there is limited evidence of the potential for contaminant migration from soil to groundwater at the CED Area. Historical shallow groundwater data are available, and such data allow for an understanding of potential chemical migration from soil to groundwater, but the data are relatively old and incomplete for some possible COCs. Therefore, additional data must be collected from select upgradient and CED Area wells to better evaluate the potential for leachability of COCs from soil to groundwater.

**Problem No. 3: Characterization of Vapor Intrusion Potential at Sites 02/03.** The Navy is currently preparing an FFS for the CED Area soils. A VOC groundwater plume emanating primarily from an *upgradient* United States Army Corps of Engineers (USACE) source area underlies soil at the CED Area. The FFS is for CED Area soils and does require an understanding of the potential for vapor intrusion (i.e., whether VOCs can migrate from the groundwater plume to the indoor air of a future building constructed atop the CED Area). Land use controls may be necessary to mitigate the potential for vapor intrusion. Historical VOC data are available for the shallow groundwater zone, but most of the available data are dated. A current round of VOC data for this zone would allow a comprehensive understanding of the potential for vapor intrusion and would support the FFS. Therefore, data must be collected from select CED Area shallow-zone wells to support an evaluation of the potential for vapor intrusion.

**Problem No. 4: Characterization of Groundwater at CED Area Drum Removal Area.** As noted in [Section 4.1](#), the Navy performed a Time-Critical Removal Action at the CED Area Drum Removal Area in October 2013. Soil data were collected during the removal action (for a wide range of target analytes) ([Appendix C](#)), and a risk assessment for the soil data is planned. Groundwater data were not collected during the removal action. The removal action included the installation of monitoring wells, but not

sampling and analysis of these wells. Groundwater data must be collected from the monitoring wells to determine whether groundwater has been impacted by releases from drums.

## 5.2 DATA NEEDS

Data and information that are required to resolve the problem statements described in [Section 5.1](#) are as follows:

- Screening-level data for soils [organic vapor concentrations as measured with a photoionization detector (PID)], needed to address Problem No. 1.
- Fixed-base laboratory concentrations of TPH in surface and subsurface soil samples collected from shallow soil borings advanced using direct-push technology (DPT) (see [Worksheet #8](#) and [Worksheet #9](#) for details regarding analytical methods and analytes, respectively), needed to address Problem No. 1.
- Fixed-base laboratory concentrations of Target Compound List (TCL) VOCs, naphthalene, metals (total and dissolved), and TPH in groundwater samples collected from existing shallow wells in the CED Area (see [Worksheet #8](#) and [Worksheet #9](#) for details regarding analytical methods and analytes, respectively), needed to address Problems No. 2 and 3.
- Fixed-base laboratory concentrations of TCL VOCs, TCL SVOCs, TCL pesticides/PCBs, metals (total and dissolved), and TPH in groundwater samples collected from new wells (see [Worksheet #8](#) and [Worksheet #9](#) for details regarding analytical methods and analytes, respectively), needed to address Problem No. 4.
- For *delineating* TPH soil contamination at Site 03, the RIDEM residential DEC and GA leachability criterion will be used (500 mg/kg). [However, the risk management decisions made for Site 03 based on the data collected in this SAP may also consider the RIDEM industrial/commercial DEC and GB leachability criterion (2,500 mg/kg)]. These criteria will be used to address Problem No. 1.
  - To identify chemicals of potential concern (COPC) in groundwater collected to address Problem Nos. 2, 3, and 4, groundwater data will be compared to the lesser of the following applicable COPC groundwater screening levels:
    - USEPA RSLs for tap water, except that RSLs established based on non-cancer effects will be adjusted to represent a hazard index (HI) of 0.1.
    - RIDEM GA/GB criteria for water.

- USEPA Safe Drinking Water Act (SDWA) Maximum Contaminant Levels (MCLs)
- USEPA Vapor Intrusion Screening Levels for Groundwater presented in the guidance for the Vapor Intrusion Screening Level (VISL) Calculator, Version 3.3, May 2014 RSLs. Details are provided on [Worksheet #9](#).
- Global positioning system (GPS) coordinates (sub-meter accuracy) of soil sampling locations. All spatial locations measured relative to the North American Datum (NAD) of 1983, State Plane Coordinate System of Rhode Island (feet). The GPS coordinates are needed to address Problem No. 1.
- For all monitoring wells, ground surface elevations and top-of-riser elevations, needed to address Problem Nos. 2, 3, and 4.
- Depths of soil samples with reference to the ground surface, needed to address Problem No. 1.
- For groundwater samples, the depths to groundwater relative to the tops of the inner well casings. The measurements will be converted to groundwater elevations in the National Geodetic Vertical Datum (NGVD) of 1988. This information is needed to address Problem Nos. 2, 3, and 4.
- For wells developed and sampled during the field investigation, groundwater turbidity, temperature, dissolved oxygen (DO), pH, specific conductance (conductivity), salinity, and oxidation-reduction potential (ORP), needed to address Problem Nos. 2, 3, and 4.
- Lithologic data for all soil samples collected, needed to address Problem No. 1.
- Quality control (QC) sample data. It may be necessary to use cooler temperature blanks in coolers containing samples scheduled for all laboratory analyses except metals. Field duplicate samples will be collected at a frequency of one duplicate sample for every 20 environmental samples. Equipment rinsate blanks will be collected at a frequency of one rinsate blank for every 20 environmental samples. QC sample data are needed to address Problem Nos. 1, 2, 3, and 4.
- Analytical data reported by the laboratory use the following reporting conventions: All results less than detection limits (DLs) will be considered non-detects. Positive results reported at concentrations between the DL and limit of quantitation (LOQ) will be reported with a "J" qualifier, and analytes not detected in a sample will be reported as the limit of detection (LOD) with a "U" qualifier. In cases where laboratory LODs are greater than project screening levels (PSLs), consistent with the USEPA Risk Assessment Guidance for Superfund, Part A (USEPA 1989), if the analyte is not detected, the LOD will be reported and "U" qualified. An evaluation of these analytes will be presented in the

uncertainty section of reports prepared for this investigation. These reporting conventions will apply to analytical data collected to address Problem Nos. 1, 2, 3, and 4.

- The cumulative cancer risk benchmark for receptors hypothetically exposed to COCs identified for the CED Area is  $1E-04$  (i.e., a 1-in-10,000 probability of developing cancer). However, if unacceptable Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) risks are estimated for an environmental medium, Applicable or Relevant and Appropriate Requirements (ARARs) established by the State of Rhode Island will also be used in risk management decision making. This cumulative cancer risk benchmark applies to Problem Nos. 2, 3, and 4.
- The cumulative non-cancer hazard benchmark for receptors hypothetically exposed to COCs identified for the CED Area is an HI of 1. This cumulative non-cancer hazard benchmark applies to Problem Nos. 2, 3, and 4.
- Project action limits (PALs) are the cumulative cancer or non-cancer benchmarks defined above (i.e., an ILCR of  $1E-04$  or an HI of 1).

Any new data evaluations or risk estimation necessary to address the problem statements presented above will be conducted per the protocols established in the Final Human Health Risk Evaluation for the Construction Equipment Department, (Tetra Tech, 2014) or Phase III RI Report for Site 16 (Tetra Tech, 2009). The evaluation of the TPH concentrations in soils and groundwater will be a comparison of detected concentrations to RIDEM ARARs. Any 95% upper confidence limits (UCLs) used as exposure point concentrations (EPC) required for data evaluations will be calculated per guidance established in the most current version of USEPA's Pro-UCL guidance. J-flagged data will be acceptable to achieve project goals; however, greater scrutiny will be applied in these cases.

### 5.3 STUDY BOUNDARIES

**Problem No. 1, Delineation of TPH-Contaminated Soil at Site 03.** Site 03 (within the CED Area) is bounded (approximately) to the east by Site 02, to the north by Battalion Boulevard, and to the south by Parade Road, and the western boundary is approximately 95 feet west of the approximate location of MW03-03S. Soils of concern are surface and shallow subsurface (vadose zone) soils. As noted previously, the conceptual site model (CSM) and historical RI data for Site 03 indicate that the TPH contamination most likely resulted from releases at the surface. There are no temporal bounds on the soil data to be evaluated; therefore, available historical data will be considered (e.g., evaluated qualitatively). However, because historical soil boring locations will be resampled as specified in the SAP (see [Figure 4-3](#)) and because the new soil samples will be analyzed per the current analytical procedures



specified in this SAP, it is anticipated that risk management decisions will be made based on the new data.

Two populations of soil are of interest for Site 03, soil contaminated by site operations (at concentrations exceeding RIDEM criteria) and soil not contaminated by past site operations (at concentrations less than or equal to RIDEM criteria) that helps to delineate the extent of site-related contamination. The populations of interest are subdivided into surface soil (generally 0 to 2 feet bgs) and subsurface soil (2 feet to 10 feet, approximate top of water table). Based on the CSM, TPH contamination is not expected to be deeper than 4 feet bgs.

**Problems No. 2/3, Characterization of Groundwater/Vapor Intrusion Potential at Sites 02/03.** Site 02 is bounded to the east by the approximate location of the eastern edge of former Building 224, to the north by Battalion Boulevard, to the south by MW02-11S, and the west by Site 03. The Site 03 boundaries are defined under Problem No. 1. The first groundwater population of interest is the shallow groundwater within or immediately downgradient of Site 02/03 sources areas. This is the groundwater zone most likely impacted by contaminants potentially leaching from soils. Additionally, VOC contamination in this shallow zone is evaluated when determining the potential for vapor intrusion (i.e., migration from groundwater to soil gas to the indoor air of a building). The second groundwater population of interest is shallow groundwater upgradient of these source areas. Groundwater data obtained during the field event proposed in this SAP will be used to address Problem Nos. 2 and 3 because most of the historical groundwater data available for Sites 02/03 were collected over 10 years ago and may not reflect current site conditions.

**Problem No. 4, Characterization of Groundwater at CED Area Drum Removal Area.** The CED Area Drum Removal Area is located approximately 200 feet north of Study Area 04 and approximately 200 feet south of the bike path located along Perimeter Road. Seabee Avenue is located immediately west. The geophysical survey conducted for the area encompasses approximately 180 by 300 feet and was centered on an approximately 30-foot-diameter hole where buried 55-gallon steel drums were discovered during earthwork conducted by QDC in April 2013. The drums have been removed and wells installed under a different SAP. The groundwater populations of interest are shallow- and intermediate-zone groundwater zones potentially impacted by releases from the drums discovered in this area or the upgradient source.

## 5.4 ANALYTIC APPROACH

The following decision rules will be used to resolve the problem statements presented in [Section 5.1](#):



**Decision Rule for Problem No. 1, Delineation of TPH-Contaminated Soil at Site 03:** If all TPH data have been collected as planned (see [Worksheet #7](#) and [Table 8-1](#)) and contamination has been delineated to less than the RIDEM residential DEC and GA leachability criteria, with no significant quality deficiencies, consider the delineation of soil contamination complete (see Note 1 below) and proceed with the data evaluation to determine whether soil remediation is required under RIDEM regulations. Otherwise, convene the Project Team to determine whether additional site delineation is warranted.

**Decision Rules for Problems Nos. 2 and 3, Characterization of Groundwater/Vapor Intrusion Potential at Sites 02/03:** If target analytes are detected in groundwater samples collected during the sampling of monitoring wells *and* determined to be COPCs for direct contact/vapor intrusion, then conduct a risk evaluation using all applicable COPCs. If no COPCs are selected, no risk evaluation is necessary for direct contact/vapor intrusion. An update of the analysis (see Note 3 below) of the potential for chemical migration from soil to groundwater presented in the 2014 CED Area soils risk assessment will be included. If a risk evaluation identifies COCs (see Note 2 below), convene the Project Team to determine the appropriate course of action (see Note 4 below). Else, no further action is necessary.

**Decision Rules for Problem No. 4, Characterization of Groundwater at CED Area Drum Removal Area:** If target analytes are detected in groundwater samples collected during the sampling of monitoring wells *and* determined to be COPCs for direct contact/vapor intrusion, then conduct a risk evaluation using all applicable COPCs. If no COPCs are selected, no risk evaluation is necessary for direct contact/vapor intrusion. An analysis of the potential for chemical migration from soil to groundwater (see Note 3 below) based on soil data collected at the CED Area Drum Removal Area will be included. If a risk evaluation identifies COCs (see Note 2 below), convene the Project Team to determine the appropriate course of action (see Note 4 below). Otherwise, no further action is necessary.

**Note 1:** The team will consider the following factors when determining whether the TPH delineation is complete: (1) field observations, (2) field screening results, (3) spatial distribution of TPH contamination, particularly with regard to exceedances of RIDEM criteria, and (4) extent to which soils have been delineated to RIDEM residential criteria/GA criteria compared to RIDEM industrial/commercial/GB criteria.

**Note 2:** A COPC is a chemical detected at concentrations exceeding background concentrations *and* conservative PSLs for HHRA as defined in [Worksheet #9](#) and support documentation. (Because a formal background data set for groundwater is not available for the CED Area, upgradient groundwater concentrations, as described in [Section 5.1](#), will be used for comparison with site groundwater concentrations to determine COPCs. To account for uncertainty associated with the upgradient groundwater data set, risks will be evaluated two ways: 1) after eliminating chemicals greater than screening levels but within the range of upgradient concentrations, and 2) including all chemicals greater

than screening levels.) A COC is a COPC that should be further evaluated in a feasibility study. COCs are identified when risk estimates exceed risk management benchmarks (PALs) established for a site (defined in [Section 5.2](#)) and are often referred to as “risk drivers” for an environmental medium. In some cases, COCs are also identified because of exceedances of ARARs (e.g., RIDEM direct exposure criteria or federal SDWA MCLs).

**Note 3:** The team will consider a number of factors when determining whether the available soil and groundwater data suggest that there is chemical migration from soil to groundwater. These factors include, but are not limited to, those presented in Section 4.1.3 (Refinement of Groundwater Protection COPCs) of the Final Human Health Risk Evaluation for the Construction Equipment Department (Tetra Tech, 2014).

**Note 4:** Groundwater underlying the CED Area has been impacted by groundwater contamination migrating into the area from the upgradient Nike PR-58 site currently under investigation by USACE.

## 5.5 PERFORMANCE CRITERIA

The Project Team will use the results of this investigation to determine whether the amount, type, and quality of data collected are sufficient to resolve the problem statements presented in this SAP (i.e., there are no significant post-investigation data gaps). Spatial contamination patterns, contamination levels, the ability to collect data from intended populations, and analytical sensitivity, among other factors, will be evaluated. To evaluate data quality, the processes and criteria described in [Worksheet #12](#) will be used. Data quality deficiencies must be brought to the attention of all Project Team members for their consideration as to how the deficiencies affect attainment of project objectives (see also [Section 5.4](#)). If any data gaps are identified, including missing or rejected data, the Project Team will assess whether project objectives can be achieved despite the existence of data gaps. This assessment will depend on the number and type of identified data gaps. All Project Team members will be involved in rendering the final conclusion regarding adequacy of the data. U-flagged values will not be used to classify a sampling point as contaminated. If no data gaps are identified by the Project Team and data quality is acceptable, the data collected will be considered sufficient to make risk management decisions for the site and to support the ongoing FFS for CED Area soil.

## 5.6 SAMPLING DESIGN AND RATIONALE

The detailed sampling design is presented in [Worksheet #7](#).

## 6.0 – Field Quality Control Samples

(UFP-QAPP Manual Section 2.6.2 – Worksheet #12)

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria (MPCs)	QC Sample Assesses Error for Sampling (S), Analytical (A) or Both (S&A)
Trip Blanks	VOCs and TPH-GRO (MTBE through naphthalene)	One per cooler.	Bias/Contamination	No analytes $\geq \frac{1}{2}$ LOQ, except common laboratory contaminants, which must be $< \text{LOQ}$ .	S & A
Equipment Rinsate Blanks	All analytical groups	One per 20 field samples collected per matrix.	Bias/Contamination	No analytes $\geq \frac{1}{2}$ LOQ, except common laboratory contaminants, which must be $< \text{LOQ}$ .	S & A
Duplicate Samples	All analytical groups	One per 20 field samples collected per matrix.	Precision	Values $> 5X \text{ LOQ}$ : Relative Percent Difference (RPD) must be $\leq 30\%$ <sup>(1)(2)</sup> (aqueous), $\leq 50\%$ <sup>1,2</sup> (soils).	S & A
Cooler Temperature Indicator	All analytical groups	One per cooler.	Representativeness	Temperature must be between 0 and 6 degrees Celsius ( $^{\circ}\text{C}$ ).	S

1 – If duplicate values for non-metals are less than five times the LOQ, the absolute difference should be less than two times the LOQ.

2 – If duplicate values for metals are less than five times the LOQ, the absolute difference should be less than four times the LOQ.

GRO – Gasoline-Range Organics.

MTBE – Methyl tert-butyl ether.

## 7.0 -- Sampling Design and Rationale

(UFP-QAPP Manual Section 3.1.1 – Worksheet #17)

[Worksheet #7](#) summarizes the sampling design, which identifies the sampling locations, media to be sampled, and analyses. Sampling locations are illustrated on [Figure 4-3](#) for soil and [Figure 4-4](#) for groundwater, and a table of samples is provided in [Table 8-1](#). Soil borings will be advanced using DPT (macrocore samplers) to collect surface and subsurface soil samples. Sampling and other field task methodologies are described in [Worksheet #8](#).

### 7.1 SOIL BORINGS AT SITE 03

For soil sample location selection at Site 03 (Problem Statement 1), a grid encompassing the areal extent of known TPH contamination was established based on a 50-foot by 50-foot grid spacing. A soil boring will be advanced at each selected grid node shown on [Figure 4-3](#); however, some grid nodes (boring locations) were adjusted to allow for resampling of previous locations at which TPH concentrations exceeded RIDEM criteria. Therefore, both “biased samples” (i.e., samples from locations with previous TPH exceedances) and “grid samples” (i.e., samples collected from locations on the grid where no historical samples were collected) will be collected to confirm historical sampling results and to delineate the horizontal extent of contamination.

A DPT rig will be used to advance a shallow soil boring at each of the 35 locations depicted on [Figure 4-3](#) (03SB001 through 03SB035). Four soil samples will be collected from each soil boring location, one surface soil (0 to 2 feet bgs) and three subsurface soil (2 to 4 feet bgs, 4 to 6 feet bgs, and 6 to 10 feet bgs) samples. Samples from all depth intervals will be screened in the field using a PID (for the potential presence of volatile organic chemicals) and visually examined for the presence of staining, etc. All samples will be submitted to the subcontract analytical laboratory for TPH-diesel-range organics (DRO) (C9-C40) and TPH-GRO (MTBE through naphthalene) analysis.

The analytical laboratory will analyze the top two depth intervals (0 to 2 feet bgs and 2 to 4 feet bgs) from all boring locations for TPH-DRO (C9-C40) and TPH-GRO (MTBE through naphthalene); samples from the deeper depth intervals will be placed on hold pending instructions from Navy/Tetra Tech. The subcontract laboratory will submit the raw (unvalidated) data for the 0- to 2- and 2- to 4-foot depth intervals via e-mail to the Navy/Tetra Tech for review as soon as the raw data are available. Soil samples from the deeper depth intervals will be analyzed for TPH-DRO (C9-C40) and TPH-GRO (MTBE through naphthalene) only as instructed by the Navy/Tetra Tech. The Navy/Tetra Tech will select soil samples from deeper depths (4 to 6 and 6 to 10 feet bgs) for fixed-base laboratory analysis based on: (1) the field observations, (2) field screening results, and (3) evaluation of raw TPH-DRO (C9-C40) and TPH-GRO

(MTBE through naphthalene) data for the 0- to 2- and 2- to 4-foot depth intervals. The intent is to analyze the deeper intervals only if necessary to complete the vertical delineation of contamination. The decision not to automatically analyze all soil depth intervals was based on an expectation that very few locations need to be investigated to depths greater than approximately 4 feet bgs because the contamination at Site 03 is likely to be the result of surface releases based on the CSM (see [Section 4.1](#)).

The soil sample design for Site 03, consisting of biased locations selected based on historical data and locations selected using a grid, will result in a sample density that is relatively high. Consequently, the need for additional data collection is expected to be low (unless it is due to data quality deficiencies), and any required additional data collection could be accomplished as the initial step of any removal action necessary under RIDEM regulations.

## 7.2 GROUNDWATER SAMPLES

[Table 7-1](#) provides the primary rationale for the selection of monitoring wells to be sampled to address Problem Statement Nos. 2 and 3. For Site 02, wells downgradient of where naphthalene was previously detected in subsurface soil (MW02-04S and MW02-10S) were selected for sampling. VOC contamination was also detected at MW02-10S in samples collected in 2007. Additionally, well 25MW-01S at Site 02 was selected for sampling primarily because previous VOC contamination was detected at this well. For Site 03, wells downgradient of Site 03 (MW03-04S and MW03-05S) were selected for sampling primarily because TPH soil contamination was detected at locations scattered across Site 03. Additional wells across Sites 02 and 03 (listed in [Table 7-1](#)) were also recommended for sampling to obtain adequate spatial coverage of the sites and to provide data needed to address remaining concerns regarding the potential for migration of metals from soil to groundwater. Regardless of the primary reason for sampling at a particular Site 02/03 well, samples from all of the selected wells will be analyzed for the same target analyte list (specified in [Table 8-1](#)).

[Table 7-1](#) also includes three wells (MW01-10S, MW01-13S, and MW01-14S) selected for sampling to provide data regarding CED-area-specific upgradient conditions, particularly for metals. These wells were selected as potentially unimpacted wells because they are located upgradient and/or distal from the CED source areas and, based on historical data, contained very low-level VOC and metals contamination. These wells will be sampled for the same target analyte list as the other CED Area wells (specified in [Table 8-1](#)).

[Table 7-1](#) also identifies each of the six newly installed monitoring wells at the CED Drum Removal Area that will be sampled to characterize water quality at and downgradient of the area where drums were excavated (Problem No. 4). Monitoring wells MW03-17S and MW03-17I are located in the immediate

vicinity of the drum excavation area, and monitoring wells MW03-16S and MW03-16I are located downgradient of the excavation area, as shown on [Figure 4-4](#). Monitoring wells MW03-15S and MW03-15I are likely installed sidegradient of the drum excavation area, although it is possible given the presence of wetland features to the north of the site that these wells could be seasonally downgradient of the excavation area (especially MW03-15S). The following table briefly summarizes the rationale for the screen depth interval selected for each new well.

<b>CED Drum Removal Area Well</b>	<b>Screened Interval (feet bgs)</b>	<b>Rationale for Screened Interval</b>
MW03-15S	13 to 23	Characterize shallow groundwater/water table zone. Evaluate potential shallow migration to north.
MW03-15I	45 to 55	Characterize intermediate groundwater zone. Evaluate potential migration from shallow zones to deeper zones. Evaluate potential intermediate migration to north and/or migration from shallow zone.
MW03-16S	11.5 to 21.5	Characterize shallow groundwater/water table zone and potential migration downgradient of excavation area.
MW03-16I	45 to 55	Characterize intermediate groundwater zone. Evaluate potential migration from shallow zones to deeper zones and potential migration downgradient of excavation area.
MW03-17S	11.5 to 21.5	Characterize shallow groundwater/water table zone in the excavation area (potential source area).
MW03-17I	45 to 55	Characterize intermediate groundwater zone. Evaluate potential migration from shallow zones to deeper zones in the excavation area (potential source area)

Installation of these wells is beyond the scope of this SAP (i.e., the document does not provide the DQOs or specifications for well installation). The preceding information is provided for purposes of completeness and to facilitate regulatory review. Depth to groundwater is estimated to be between 15 and 20 feet bgs in this area based on boring logs completed during well installation in early February 2014. The target analyte list for the fixed-base laboratory samples to be collected from these newly installed wells is specified in [Table 8-1](#) and is more extensive than the analyte list specified for the existing wells.

Water quality parameters will be measured and logged in the field for all existing and newly installed wells sampled. These parameters include DO, specific conductance, temperature, pH, ORP, and turbidity. Water level measurements will be collected from each well at the time of sample collection.

A total of 17 existing shallow wells at Sites 02/03 (listed in [Table 7-1](#)) will be sampled. Fourteen of the shallow wells are associated with Sites 02 and 03 and will be sampled to characterize groundwater at these sites and to support the FFS for CED Area soils. Three additional wells, upgradient and/or distal

from these sites, will be sampled to provide CED Area-specific upgradient data. All groundwater samples from these wells will be analyzed for TCL VOCs, naphthalene, target analyte list (TAL) metals (total and dissolved), and TPH-DRO (C9-C40) and TPH-GRO (MTBE through naphthalene). Groundwater samples collected from the newly installed wells at the Drum Removal Area will be sampled for TCL SVOCs and TCL pesticides/PCBs in addition to the parameters listed above for existing wells.

**TABLE 7-1**  
**WELLS IDENTIFIED FOR ADDITIONAL SAMPLING**

<b>Well ID</b>	<b>Primary Rationale for Sampling</b>
MW01-10S, MW01-13S and/or MW01-14S <sup>(1)</sup>	Based on historical data, very low-level VOC concentrations and low metals concentrations only. Recommended to potentially provide data regarding CED-area-specific upgradient conditions, particularly for metals.
25MW-01S <sup>(1)</sup>	VOC contamination previously detected.
MW02-04S <sup>(1)</sup>	Recommended primarily for naphthalene sampling. Naphthalene was detected in sample 02-B15-04-6-8 in Site 02 subsurface soil. This well is likely downgradient of location 02-B15-04-6-8. MTBE detected in 2007 samples.
MW02-05S <sup>(1)</sup>	Recommended primarily for metals sampling. MW02-05S is likely downgradient of metals concentrations in Site 02 surface soil exceeding refined groundwater protection criteria and facility background concentrations (e.g., 02-B17-01). MTBE detected in 2007 sample.
MW02-06S <sup>(1)</sup>	Recommended primarily for metals sampling. MW02-06S is likely downgradient from metals concentrations exceeding refined groundwater protection criteria (e.g., 02-B15-01).
MW02-08S <sup>(1)</sup>	Recommended primarily for metals sampling. MW02-08S is likely downgradient of elevated concentrations of some metals in Site 02 subsurface soil (detected at B-02-08-04-S and B-02-10-08-S) and maximum concentrations of some metals in Site 02 subsurface soil (detected at B-02-10-04-S). Some metals concentrations in Site 02 subsurface soil exceeded refined groundwater protection criteria and facility background concentrations.
MW02-09S <sup>(1)</sup>	Recommended primarily for metals sampling. MW02-09S is likely downgradient of maximum metals concentration in Site 02 surface soil (detected at 02-B17-01). Metals concentrations in Site 02 surface soil exceeded refined groundwater protection criteria and facility background concentrations.
MW02-10S <sup>(1)</sup>	Recommended primarily for naphthalene sampling. Naphthalene was detected in sample 02-B15-04-6-8 in Site 02 subsurface soil. This well is downgradient of location 02-B15-04-6-8. VOC contamination detected in 2007 samples.
MW03-01S <sup>(1)</sup>	Recommended primarily for metals sampling. MW03-05S is downgradient of maximum concentrations of some metals in Site 03 surface soil (detected at S-03-03-00-S and B-03-02-06-S). Some metals concentrations in Site 03 surface soil exceeded refined groundwater protection criteria and facility background concentrations.
MW03-02S <sup>(1)</sup>	Recommended primarily for metals sampling. MW03-02S is co-located with maximum concentrations of some metals in Site 03 subsurface soil. Some metals concentrations in Site 03 subsurface soil exceeded refined groundwater protection criteria and facility background concentrations.
MW03-04S <sup>(1)</sup>	Recommended primarily for TPH sampling. TPH concentrations exceeding groundwater protection criteria were scattered across Site 03 (i.e., locations SS3C-1 and S-03-01-00-S through S-03-10-00-S). This well is likely downgradient of Site 03. Available shallow groundwater samples do not include TPH results.



Well ID	Primary Rationale for Sampling
MW03-05S <sup>(1)</sup>	Recommended primarily for TPH sampling. TPH concentrations exceeding groundwater protection criteria are scattered across Site 03 (i.e., locations SS3C-1 and S-03-01-00-S through S-03-10-00-S). This well is likely downgradient of Site 03. Available shallow groundwater samples do not include TPH results.
MW03-03S <sup>(1)</sup>	Added at the suggestion of USEPA Region I to further characterize the nature and extent of any groundwater contamination in the CED Area.
MW02-11S <sup>(1)</sup>	Added at the suggestion of USEPA Region I to further characterize the nature and extent of any groundwater contamination in the CED Area.
MW02-03S <sup>(1)</sup>	Added at the suggestion of USEPA Region I to further characterize the nature and extent of any groundwater contamination in the CED Area.
All New Drum Area Wells <sup>(2)</sup>	Recommended in support of drum removal investigation to the northwest of existing CED Area sites.

- 1 Existing wells to be sampled for TCL VOCs, naphthalene, TAL metals (total and dissolved), and TPH-DRO (C9-C40) and TPH-GRO (MTBE through naphthalene).
- 2 New drum area wells to be sampled for TAL metals (total and dissolved) and TCL VOCs, SVOCs, pesticides/PCBs, and TPH-DRO (C9-C40) and TPH-GRO (MTBE through naphthalene).

## **8.0 – Field Project Implementation (Field Project Instructions)**

([UFP-QAPP Manual Section 5.2.3](#))

### **8.1 FIELD PROJECT TASKS**

([UFP-QAPP Manual Section 2.8.1 – Worksheet #14](#))

Field tasks activities to be conducted for this SAP are as follows:

- Mobilization/demobilization and utility clearance
- Field instrument calibration
- Sample collection, handling, and shipping
- Soil boring advancement – DPT and soil sample collection (surface and subsurface)
- Redevelopment of existing groundwater wells
- Collection of synoptic water levels
- Groundwater purging and sampling
- GPS locating
- Collection of field QC samples
- Investigation-derived waste (IDW) management
- Field decontamination

#### **Mobilization/Demobilization and Utility Clearance**

This task includes the mobilization of staff to the site; field team orientation/site walkover; procurement and delivery of all equipment, materials, and supplies to the site; complete assembly, in satisfactory working order, of all such equipment at the site, and satisfactory storage of all such materials and supplies at the site. Field team members will review this SAP and the associated project Health and Safety Plan (HASP) (provided under separate cover). Site-specific health and safety training will also be provided to all Tetra Tech field personnel and subcontractors as part of site mobilization.

Demobilization will consist of the prompt and timely removal of all equipment, materials, and supplies from the site following completion of the work. Demobilization will also include the removal and proper disposal of waste generated during the conduct of the investigation (i.e., IDW) in accordance with [SOP-15](#) (Management of Investigation-Derived Waste, [Appendix D](#)) and RIDEM Policy Memo 95-01 - Guidelines for the Management of Investigation Derived Wastes (RIDEM, 1995).

No intrusive activities (e.g., drilling, direct-push sampling) will occur until the proposed areas intended for subsurface sampling have been completely cleared in accordance with [SOP-01](#) (Utility Location and Excavation Clearance, [Appendix D](#)).

### **Field Instrumentation Calibration**

The field equipment used during this investigation will be calibrated and maintained as outlined in the following table.

### **Field Equipment Calibration, Maintenance, Testing, and Inspection Table**

(UFP-QAPP Manual Section 3.1.2.4)

<b>Field Equipment</b>	<b>Activity<sup>(1)</sup></b>	<b>Frequency</b>	<b>Acceptance Criteria</b>	<b>Corrective Action</b>	<b>Standard Operating Procedure (SOP) Reference</b>
PID	Visual Inspection  Calibration/ Verification	Daily  Beginning and end of day	Manufacturer's guidance	Operator correction or Replacement	Operation according to manufacturer's instructions
QED Bladder Pump Control Box (or equivalent)	Visual Inspection  Field checks per manufacturer	Daily  Once upon receiving from vendor	Manufacturer's guidance	Operator correction or Replacement	<a href="#">SOP-09</a> and <a href="#">SOP-10</a>
YSI 556 Series Water Quality Meter (or equivalent)	Visual Inspection  Calibration/ Verification	Daily  Beginning and end of day	Manufacturer's guidance	Operator correction or Replacement	<a href="#">SOP-10</a>
Turbidity Meter	Visual Inspection  Calibration/ Verification	Daily  Beginning and end of day	Manufacturer's guidance	Operator correction or Replacement	<a href="#">SOP-10</a>
Water Level Indicator	Visual Inspection  Field checks as per manufacturer	Daily  Once upon receiving from vendor	0.01 foot accuracy	Operator correction or Replacement	<a href="#">SOP-09</a>

- 1 Rental equipment and instruments will be used in the field. The rental firms will be responsible for the proper care, maintenance, and repair of these items and for tracking and documenting equipment and instrument maintenance and repairs.

### **Sample Collection Tasks and Handling and Shipping**

The sampling and analysis program is outlined in [Worksheet #7](#) and [Table 8-1](#). Sample collection will be in accordance with the site-specific SOPs listed in [Section 8.2](#) and provided in [Appendix D](#). The sampling requirements for each type of analysis (i.e., bottleware, preservation, holding time) are listed in [Table 8-2](#). Field and laboratory QC samples will be collected as outlined in [Table 8-3](#).

Sample handling and shipping procedures presented in SOPs [SOP-02](#) through [SOP-05](#) will be followed. Sample containers will be provided certified clean (I-Chem 300 or equivalent) from the analytical laboratory. Sample labeling will be in accordance with [SOP-02](#) (Sample Labeling, [Appendix D](#)), and the sample numbering scheme will be in accordance with [Table 8-1](#) and [SOP-03](#) (Sample Identification Nomenclature, [Appendix D](#)). The selection of sample containers, sample preservation, sample custody (including field documentation) packaging, and shipping will be in accordance with [Table 8-2](#) and SOPs [SOP-04](#) (Sample Custody and Documentation of Field Activities, [Appendix D](#)) and [SOP-05](#) (Sample Preservation, Packaging, and Shipping, [Appendix D](#)).

### **Soil Boring Advancement – DPT and Soil Sample Collection (Surface and Subsurface)**

Surface and subsurface soil samples will be collected from 35 sampling locations ([Table 8-1](#)) in accordance with [SOP-06](#) (Borehole Advancement and Soil Coring Using DPT and Hand Auger Techniques, [Appendix D](#)). DPT will be used to collect surface and subsurface samples at combined surface and subsurface soil sample locations (all locations). The soil borings will be screened with a PID to identify the presence of VOCs in soil cores, and lithologies will be described by field personnel in accordance with [SOP-07](#) (Borehole and Sample Logging, [Appendix D](#)). Any qualitative visual signs of potential contamination (such as soil staining) will be recorded on the soil boring log. The surface and subsurface soil samples will be collected in accordance with [SOP-08](#) (Surface and Subsurface Soil Sampling, [Appendix D](#)).

### **Redevelopment of Existing Groundwater Monitoring Wells**

The seventeen existing monitoring wells ([Figure 4-4](#)) will be redeveloped in accordance with [SOP-09](#) (Monitoring Well Development, [Appendix D](#)). These groundwater monitoring wells are being redeveloped since many have not been sampled in over three years. Redeveloping will ensure that proper hydraulic connection between the well and aquifer is attained. Wells will be redeveloped a minimum of 7 days before sample collection.

### **Collection of Synoptic Water Levels**

A synoptic round of water levels will be collected in accordance with [SOP-10](#) (Measurement of Water Levels in Monitoring Wells, [Appendix D](#)). The synoptic event will include the 23 existing and new monitoring wells listed in [Table 8-1](#). If present, any other nested wells within the 17 existing wells will also be gauged and included in the synoptic event.

### **Groundwater Purging and Sampling**

Groundwater samples will be collected in accordance with SOPs [SOP-11](#) (Groundwater Sample Acquisition and Onsite Water Quality Testing, [Appendix D](#)) and [SOP-12](#) [Low Stress (Low Flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells, [Appendix D](#)]. Groundwater samples will be collected from a total of 23 existing and new monitoring wells listed in [Table 8-1](#). Seventeen existing monitoring wells will be sampled for TCL VOCs, naphthalene, total and dissolved metals, and TPH-DRO (C9-C40) and TPH-GRO (MTBE through naphthalene), and the six new monitoring wells will be sampled for TCL VOCs, SVOCs, pesticides, and PCBs, total and dissolved metals, and TPH-DRO (C9-C40) and TPH-GRO (MTBE through naphthalene).

### **Global Positioning System Locating**

A GPS unit will be used to locate all soil sampling points in accordance with [SOP-13](#) (Global Positioning System, [Appendix D](#)). The GPS equipment will be checked on control monuments before and after each day's use, and these checks will be documented in the field logbook. To ensure sub-meter accuracy, the GPS SOP requires a minimum of six satellites to capture a position.

### **Collection of Field QC Samples**

Trip blanks, equipment rinsate blanks, and field duplicate samples will be collected at the frequencies listed in [Worksheet #6](#).

### **Field Decontamination Procedures**

All non-disposable equipment that comes in contact with sample media will be decontaminated according to [SOP-14](#) (Decontamination of Field Sampling Equipment, [Appendix D](#)) to prevent cross-contamination between sampling points. This includes (but is not limited to) equipment such as stainless steel bowls, scoops, and other non-disposable or dedicated equipment. Personnel decontamination is discussed in the project-specific HASP to be provided under separate cover.

### **Investigation-Derived Waste Management**

IDW includes decontamination fluids, used personal protective equipment (PPE), used sampling equipment, and excess sample material. IDW characterization and disposal will be performed after all IDW has been containerized, and IDW will be managed in accordance with [SOP-15](#) (Management of Investigation-Derived Waste, [Appendix D](#)) and RIDEM Policy Memo 95-01 - Guidelines for the Management of Investigation Derived Wastes (1995).

### **ADDITIONAL PROJECT-RELATED TASKS**

Additional project-related tasks include:

- Analytical tasks
- Data management
- Data review
- Project reports

### **Analytical Tasks**

Chemical analyses will be performed by Spectrum, which is a Department of Defense (DoD) Environmental Laboratory Accreditation Program (ELAP)-accredited laboratory. A copy of Spectrum's accreditation is included in [Appendix E](#). Analyses will be performed in accordance with the analytical methods identified in [Table 8-2](#). Spectrum will meet the PSLs specified in [Worksheet #9](#) unless otherwise noted and will perform the chemical analyses following laboratory-specific SOPs (see [Table 8-2](#) and [Worksheet #10](#)) developed based on the methods listed in [Table 8-2](#).

All soil results will be reported by the laboratory on an adjusted dry-weight basis. Results of percent moisture will be reported in each analytical data package and associated electronic data files. This information will also be included in the project database, which will eventually be uploaded to the Naval Installation Restoration Information Solution (NIRIS) database. Percent moisture information will also be included in the report prepared for the work addressed in this SAP.

The analytical data packages provided by Spectrum will be in a Contract Laboratory Program-like format, will be fully validatable, and will contain raw data, summary forms for all sample and laboratory method blank data, and summary forms containing all method-specific QC [results, recoveries, RPDs, relative standard deviations (RSDs), and/or percent differences, etc.].

## **Data Management**

The principal data generated for this project will be field data and laboratory analytical data. Field sampling log sheets will be organized by date and medium and filed in the project files. The field logbooks for this project will be used only for this site and will also be categorized and maintained in the project files after the completion of the field program. Project personnel completing concurrent field sampling activities may maintain multiple field logbooks. When possible, logbooks will be segregated by sampling activity. The field logbooks will be titled based on date and activity.

The data handling procedures to be followed by Spectrum will meet the requirements of the technical specifications. Electronic data results will be automatically downloaded into the Tetra Tech database in accordance with the proprietary Tetra Tech processes.

The Tetra Tech PM (or designee) is responsible for the overall tracking and control of data generated for the project.

Data management will include the following:

- **Data Tracking.** Data are tracked from generation to archiving in the Tetra Tech project-specific files. The Tetra Tech Project Chemist (or designee) is responsible for tracking the samples collected and shipped to Spectrum. Upon receipt of the data packages from Spectrum, the Tetra Tech Project Chemist will monitor the data validation effort, which includes verifying that the data packages are complete and that results for all samples have been delivered by Spectrum.
- **Data Storage, Archiving, and Retrieval.** The data packages received from Spectrum will be tracked in the data validation logbook. After the data are validated, the data packages will be entered into the Tetra Tech Navy CLEAN file system and archived in secure files. The field records including field log books, sample log sheets, chain-of-custody records, and field calibration logs will be submitted by the Tetra Tech FOL to be entered into the Navy CLEAN file system prior to archiving in secure project files. Project files are audited for accuracy and completeness. As documents are finalized all relevant data is uploaded electronically to NIRIS and is retained there indefinitely. Upon project completion paper copies go to the Federal Record Center for long term storage (50 years archival).
- **Data Security.** Access to Tetra Tech project files is restricted to designated personnel only. Records can only be borrowed temporarily from the project file using a sign-out system. The Tetra

Tech Data Manager maintains the electronic data files, and access to the data files is restricted to qualified personnel only. File and data backup procedures are routinely performed.

- **Electronic Data.** All electronic data is validated and qualifiers are manually added to the database. The manually entered qualifiers are verified by the DVM by direct QA, as well as an electronic verification step using proprietary Tetra Tech processes. Then data will be compiled into a NIRIS Electronic Data Deliverable (NEDD) and loaded into NIRIS in accordance with Navy procedures. This process includes a QA review of the data to ensure that the content and format of the data satisfy the requirements of NIRIS uploads. The NEDD is submitted through a data checker into NIRIS which also ensures the format is acceptable.
- **Data Review.** This review comprises data verification, validation, and usability assessment. The data verification and validation processes and requirements are described in [Worksheet #12](#). The data usability assessment will, at a minimum, constitute evaluation of the following characteristics to ensure that the amount, type, and quality of data are sufficient to achieve project objectives:
  - Comparing actual to intended sampling locations and verifying that the correct datum was used to delineate contamination.
  - Evaluating trends across sample delivery groups or sampling events.
  - Assessing quantitative relationships between parameters (e.g., relative magnitudes of trichloroethene and its degradation product concentrations).
  - Identifying potential errant or outlier data points.
  - Assessing planning assumption validity.
  - Evaluating the potential for contamination of samples by samplers.

The means of conducting these evaluations will vary depending on the nature of the data. For example, soil boring and well construction logs will generally be evaluated qualitatively or semi-quantitatively, whereas precision, accuracy, and sensitivity of analytical data will generally be evaluated quantitatively and may be based on, or may supplement, data validation findings.

DQIs to be evaluated during this assessment include the following:



- 1. Precision.** A semi-quantitative estimate of the uncertainty in contaminant concentrations as a function of location will be made.

The precision will be assessed through laboratory duplicate samples (for inorganic analyses) and matrix spike duplicate (MSD) samples (for organic analyses). These samples will be prepared and analyzed at a minimum frequency of one per every 20 environmental samples per matrix. As described in [Section 5.2](#), field duplicate samples also will be collected at a minimum frequency of one per 20 environmental samples per matrix. The RPD between a sample or matrix spike (MS) (Sample 1) and its duplicate or MSD (Sample 2) is calculated for chemical analyses using the following formula:

$$RPD = \frac{|\text{Amount in Sample 1} - \text{Amount in Sample 2}|}{0.5 (\text{Amount in Sample 1} + \text{Amount in Sample 2})} \times 100 \%$$

- 2. Accuracy.** Accuracy data will be evaluated to ensure that sampling and measurement accuracy is within or exceeds analytical method specifications and may depend in part on the data validation findings.

The accuracy of chemical analyses is assessed through the use of surrogate spikes, MSs, post-digestion spikes, laboratory control samples (LCSs), calibration check standards, internal standards, and blanks. Blanks are used to infer the potential for positive biases because of contamination. To assure the accuracy of the analytical procedures, at least one of every 20 environmental samples will be spiked with known amounts of target analytes (i.e., MSs) prior to preparation for analysis. The spiked samples will be analyzed, and the concentrations of each target analyte observed in the spiked sample will be compared to the reported value of the analyte in the unspiked sample to determine the percent recovery (%R) of the analyte. Control charts are plotted by the laboratory for each target analyte and are kept on matrix- and analyte-specific bases. The %R for a spiked sample is calculated using the following formula:

$$\%R = \frac{\text{Amount in Spiked Sample} - \text{Amount in Sample}}{\text{Known Amount Added}} \times 100 \%$$

LCSs and surrogate spikes are also analyzed to assess accuracy. The %R calculation for LCSs and surrogate spikes is as follows:

$$\%R = \frac{\text{Experimental Concentration}}{\text{Certified or Known Concentration}} \times 100 \%$$

- 3. Representativeness.** This evaluation will assess whether the data are adequately representative of intended populations based on the sample collection and data generation requirements specified in this SAP.
- 4. Completeness.** Failure to obtain critical data from planned locations will be documented. Minor variations in actual compared to intended sampling locations (or depths) that do not adversely affect the attainment of project objectives will not be documented.

Completeness for this project is determined based on the number of sample results for each target analyte and each sample type that are usable as determined through data validation and data assessment. Data values rejected during data validation (indicated by an “R” or “UR” flag) will be considered unusable unless additional review and documentation by one or more technical team members demonstrates that the rejection was erroneous.

Percent completeness will be calculated using the following equation:

$$\% \text{ Completeness} = \frac{(\text{Number of Valid Measurements})}{(\text{Number of Measurements Planned})} \times 100\%$$

The ideal objective for completeness is 100 percent (i.e., every sample planned to be collected is collected; every sample submitted for analysis yields valid data). However, samples can be rendered unusable during shipping or preparation (e.g., bottles broken or extracts accidentally destroyed), errors can be introduced during analysis (e.g., loss of instrument sensitivity, introduction of ambient laboratory contamination), or strong matrix effects can become apparent (e.g., extremely low MS recovery). These instances result in data that do not meet QC criteria. Based on these considerations, 95 percent is considered an acceptable target for the data completeness objective. If critical data points are lost, resampling and/or reanalysis may be required.

- 5. Comparability.** This will be accomplished by comparing overall precision and bias among data sets for each matrix and analytical fraction for each sampled area. This will not require quantitative comparisons unless the Tetra Tech Project Chemist indicates that such quantitative analysis is beneficial to the project and the Tetra Tech PM agrees.
- 6. Sensitivity.** The Tetra Tech Project Chemist will determine whether project sensitivity goals were achieved by comparing non-detect values to PSLs.

**7. Other quantitative characteristics.** These may include items such as verification of soil volume calculations and soil disposal cost estimates that are used to determine whether the contaminants are sufficiently well delineated to estimate remediation costs.

If significant data quality deficiencies are detected that prevent the attainment of project objectives, the limitations on the affected data will be described in the project report. The Tetra Tech PM will bring these deficiencies to the attention of the Project Team for their evaluation, and the team will determine an appropriate corrective action depending on the circumstances.

## 8.2 FIELD SOPS REFERENCE TABLE

(UFP-QAPP Manual Section 3.1.2 – Worksheet #21)

Reference Number	Title, Revision Date, and/or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
<a href="#">SOP-01</a>	Utility Locating and Excavation Clearance; Revision 3, 1/2012, HS-1.0	Tetra Tech	Remote subsurface sensing, magnetometer, ground penetrating radar (GPR)	N	Contained in <a href="#">Appendix D</a>
<a href="#">SOP-02</a>	Sample Labeling, 4/14, Revision 0.	Tetra Tech	Not applicable (NA)	N	Contained in <a href="#">Appendix D</a>
<a href="#">SOP-03</a>	Sample Identification Nomenclature, 4/14, Revision 0.	Tetra Tech	NA	Y	Contained in <a href="#">Appendix D</a>
<a href="#">SOP-04</a>	Sample Custody and Documentation of Field Activities, 4/14, Revision 0.	Tetra Tech	Field logbook, sample log sheets, boring logs	N	Contained in <a href="#">Appendix D</a>
<a href="#">SOP-05</a>	Sample Preservation, Packaging, and Shipping, 4/14, Revision 0.	Tetra Tech	NA	N	Contained in <a href="#">Appendix D</a>
<a href="#">SOP-06</a>	Borehole Advancement and Soil Coring Using Direct-Push Technology (DPT) and Hand Auger Techniques, 4/14, Revision 0.	Tetra Tech	DPT rig, stainless steel auger bucket, extension rods, and T-handle	N	Contained in <a href="#">Appendix D</a>
<a href="#">SOP-07</a>	Borehole and Sample Logging; Revision 2, 1/2012, GH-1.5.	Tetra Tech	NA	N	Contained in <a href="#">Appendix D</a>
<a href="#">SOP-08</a>	Surface and Subsurface Soil Sampling, 4/14, Revision 0.	Tetra Tech	Stainless steel auger bucket, extension rods, and T-handle, PID	N	Contained in <a href="#">Appendix D</a>
<a href="#">SOP-09</a>	Monitoring Well Development (without Driller), Revision 0	Tetra Tech	Submersible pump, water quality meter, turbidity meter	N	Contained in <a href="#">Appendix D</a>
<a href="#">SOP-10</a>	Measurements of Water Levels in Monitoring Wells, 4/14, Revision 0	Tetra Tech	Electronic water-level indicator	N	Contained in <a href="#">Appendix D</a>
<a href="#">SOP-11</a>	Groundwater Sample Acquisition and Onsite Water Quality Testing, 1/2012, Revision 8, SA-1.1	Tetra Tech	Groundwater pumps, water quality meter, turbidity meter	N	Contained in <a href="#">Appendix D</a>

Reference Number	Title, Revision Date, and/or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
<a href="#">SOP-12</a>	Low Stress (Low Flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells; Revised January 2010, GW-0001	EPA Region 1	Submersible pump, water quality meter, turbidity meter	N	Contained in <a href="#">Appendix D</a>
<a href="#">SOP-13</a>	Global Positioning System, 4/14, Revision 0.	Tetra Tech	GPS unit	N	Contained in <a href="#">Appendix D</a>
<a href="#">SOP-14</a>	Decontamination of Field Sampling Equipment, 4/14, Revision 0.	Tetra Tech	Scrub brushes, 5-gallon buckets, spray bottles, phosphate-free detergent, deionized (DI) water	N	Contained in <a href="#">Appendix D</a>
<a href="#">SOP-15</a>	Management of Investigation-Derived Waste, 4/14, Revision 0.	Tetra Tech	NA	Y	Contained in <a href="#">Appendix D</a> <sup>(1)</sup>

1 – IDW will also be handled in accordance with RIDEM Policy Memo 95-01 - Guidelines for the Management of Investigation Derived Wastes (RIDEM, 1995), as noted in [Section 8.1](#).

**Table 8-1 – Sample Details Table**

(UFP-QAPP Manual Section 3.1.1 and 3.5.2.3 – Worksheet #s 18, 19, 20, and 30)

Sample Location	Sample ID <sup>(1)</sup>	Analyses
<b>Soil - Problem No. 1</b>		
03SB001	03SS0010002	TPH-GRO (MTBE through naphthalene) and TPH-DRO (C9-C40)
	03SB0010204	
	03SB0010406	
	03SB0010610	
03SB002	03SS0020002	TPH-GRO (MTBE through naphthalene) and TPH-DRO (C9-C40)
	03SB0020204	
	03SB0020406	
	03SB0020610	
03SB003	03SS0030002	TPH-GRO (MTBE through naphthalene) and TPH-DRO (C9-C40)
	03SB0030204	
	03SB0030406	
	03SB0030610	
03SB004	03SS0040002	TPH-GRO (MTBE through naphthalene) and TPH-DRO (C9-C40)
	03SB0040204	
	03SB0040406	
	03SB0040610	
03SB005	03SS0050002	TPH-GRO (MTBE through naphthalene) and TPH-DRO (C9-C40)
	03SB0050204	
	03SB0050406	
	03SB0050610	
03SB006	03SS0060002	TPH-GRO (MTBE through naphthalene) and TPH-DRO (C9-C40)
	03SB0060204	
	03SB0060406	
	03SB0060610	
03SB007	03SS0070002	TPH-GRO (MTBE through naphthalene) and TPH-DRO (C9-C40)
	03SB0070204	
	03SB0070406	
	03SB0070610	
03SB008	03SS0080002	TPH-GRO (MTBE through naphthalene) and TPH-DRO (C9-C40)
	03SB0080204	
	03SB0080406	
	03SB0080610	
03SB009	03SS0090002	TPH-GRO (MTBE through naphthalene) and TPH-DRO (C9-C40)
	03SB0090204	
	03SB0090406	
	03SB0090610	
03SB010	03SS0100002	TPH-GRO (MTBE through naphthalene) and TPH-DRO (C9-C40)
	03SB0100204	
	03SB0100406	
	03SB0100610	

Sample Location	Sample ID <sup>(1)</sup>	Analyses
03SB011	03SS0110002	TPH-GRO (MTBE through naphthalene) and TPH-DRO (C9-C40)
	03SB0110204	
	03SB0110406	
	03SB0110610	
03SB012	03SS0120002	TPH-GRO (MTBE through naphthalene) and TPH-DRO (C9-C40)
	03SB0120204	
	03SB0120406	
	03SB0120610	
03SB013	03SS0130002	TPH-GRO (MTBE through naphthalene) and TPH-DRO (C9-C40)
	03SB0130204	
	03SB0130406	
	03SB0130610	
03SB014	03SS0140002	TPH-GRO (MTBE through naphthalene) and TPH-DRO (C9-C40)
	03SB0140204	
	03SB0140406	
	03SB0140610	
03SB015	03SS0150002	TPH-GRO (MTBE through naphthalene) and TPH-DRO (C9-C40)
	03SB0150204	
	03SB0150406	
	03SB0150610	
03SB016	03SS0160002	TPH-GRO (MTBE through naphthalene) and TPH-DRO (C9-C40)
	03SB0160204	
	03SB0160406	
	03SB0160610	
03SB017	03SS0170002	TPH-GRO (MTBE through naphthalene) and TPH-DRO (C9-C40)
	03SB0170204	
	03SB0170406	
	03SB0170610	
03SB018	03SS0180002	TPH-GRO (MTBE through naphthalene) and TPH-DRO (C9-C40)
	03SB0180204	
	03SB0180406	
	03SB0180610	
03SB019	03SS0190002	TPH-GRO (MTBE through naphthalene) and TPH-DRO (C9-C40)
	03SB0190204	
	03SB0190406	
	03SB0190610	
03SB020	03SS0200002	TPH-GRO (MTBE through naphthalene) and TPH-DRO (C9-C40)
	03SB0200204	
	03SB0200406	
	03SB0200610	
03SB021	03SS0210002	TPH-GRO (MTBE through naphthalene) and TPH-DRO (C9-C40)
	03SB0210204	
	03SB0210406	
	03SB0210610	
03SB022	03SS0220002	TPH-GRO (MTBE through naphthalene) and TPH-DRO (C9-C40)
	03SB0220204	
	03SB0220406	
	03SB0220610	

Sample Location	Sample ID <sup>(1)</sup>	Analyses
03SB023	03SS0230002	TPH-GRO (MTBE through naphthalene) and TPH-DRO (C9-C40)
	03SB0230204	
	03SB0230406	
	03SB0230610	
03SB024	03SS0240002	TPH-GRO (MTBE through naphthalene) and TPH-DRO (C9-C40)
	03SB0240204	
	03SB0240406	
	03SB0240610	
03SB025	03SS0250002	TPH-GRO (MTBE through naphthalene) and TPH-DRO (C9-C40)
	03SB0250204	
	03SB0250406	
	03SB0250610	
03SB026	03SS0260002	TPH-GRO (MTBE through naphthalene) and TPH-DRO (C9-C40)
	03SB0260204	
	03SB0260406	
	03SB0260610	
03SB027	03SS0270002	TPH-GRO (MTBE through naphthalene) and TPH-DRO (C9-C40)
	03SB0270204	
	03SB0270406	
	03SB0270610	
03SB028	03SS0280002	TPH-GRO (MTBE through naphthalene) and TPH-DRO (C9-C40)
	03SB0280204	
	03SB0280406	
	03SB0280610	
03SB029	03SS0290002	TPH-GRO (MTBE through naphthalene) and TPH-DRO (C9-C40)
	03SB0290204	
	03SB0290406	
	03SB0290610	
03SB030	03SS0300002	TPH-GRO (MTBE through naphthalene) and TPH-DRO (C9-C40)
	03SB0300204	
	03SB0300406	
	03SB0300610	
03SB031	03SS0310002	TPH-GRO (MTBE through naphthalene) and TPH-DRO (C9-C40)
	03SB0310204	
	03SB0310406	
	03SB0310610	
03SB032	03SS0320002	TPH-GRO (MTBE through naphthalene) and TPH-DRO (C9-C40)
	03SB0320204	
	03SB0320406	
	03SB0320610	
03SB033	03SS0330002	TPH-GRO (MTBE through naphthalene) and TPH-DRO (C9-C40)
	03SB0330204	
	03SB0330406	
	03SB0330610	
03SB034	03SS0340002	TPH-GRO (MTBE through naphthalene) and TPH-DRO (C9-C40)
	03SB0340204	
	03SB0340406	
	03SB0340610	



Sample Location	Sample ID <sup>(1)</sup>	Analyses
03SB035	03SS0350002	TPH-GRO (MTBE through naphthalene) and TPH-DRO (C9-C40)
	03SB0350204	
	03SB0350406	
	03SB0350610	

**Groundwater from Existing Wells - Problem Nos. 2 and 3**

MW01-10S	MW01-10S-NWG-XXXX14	TCL VOCs, naphthalene, TAL metals (total and dissolved), TPH-GRO (MTBE through naphthalene), TPH-DRO (C9-C40)
MW01-13S	MW01-13S-NWG-XXXX14	
MW01-14S	MW01-14S-NWG-XXXX14	
25MW01-S	25MW01-S-NWG-XXXX14	
MW02-04S	MW02-04S-NWG-XXXX14	
MW02-05S	MW02-05S-NWG-XXXX14	
MW02-06S	MW02-06S-NWG-XXXX14	
MW02-08S	MW02-08S-NWG-XXXX14	
MW02-09S	MW02-09S-NWG-XXXX14	
MW09-10S	MW09-10S-NWG-XXXX14	
MW03-01S	MW03-01S-NWG-XXXX14	
MW03-02S	MW03-02S-NWG-XXXX14	
MW03-04S	MW03-04S-NWG-XXXX14	
MW03-05S	MW03-05S-NWG-XXXX14	
MW03-03S	MW03-03S-NWG-XXXX14	
MW02-11S	MW02-11S-NWG-XXXX14	
MW02-03S	MW02-03S-NWG-XXXX14	

**Groundwater from New Wells - Problem No. 4**

MW03-15S	MW03-15S-NWG-XXXX14	TCL VOCs, SVOCs, and pesticides/PCBs, TAL metals (total and dissolved), TPH-GRO (MTBE through naphthalene), and TPH- DRO (C9-C40)
MW03-15I	MW03-15I-NWG-XXXX14	
MW03-16S	MW03-16S-NWG-XXXX14	
MW03-16I	MW03-16I-NWG-XXXX14	
MW03-17S	MW03-17S-NWG-XXXX14	
MW03-17I	MW03-17I-NWG-XXXX14	

- 1 For soil, sample IDs are the sample location followed by the depth interval (e.g., 0002 for the 0- to 2-foot depth interval); for groundwater, the date of sampling will be added to the end of the sample IDs (represented by “-XXXX14” in the table above).

## **Table 8-2 -- Analytical SOP Requirements Table**

**Laboratory point of contact, e-mail address, and phone number:** Ed Lawler, elawler@spectrum-analytical.com, 401-732-3400

**Laboratory Name and Address:**

Spectrum Analytical  
646 Camp Avenue  
North Kingstown, RI 02852

**Data Package Turnaround time:** 21 days

**Tentative Sampling Dates:** TBD

<b>Matrix</b>	<b>Analytical Group</b>	<b>Analytical and Preparation Method/ SOP Reference<sup>(1)</sup></b>	<b>Containers</b> (number, size, and type)	<b>Sample volume<sup>(2)</sup></b> (units)	<b>Preservation Requirements</b> (chemical, temperature, light protected)	<b>Maximum Holding Time<sup>(3)</sup></b> (preparation/analysis)
Aqueous	TCL VOCs	SW-846 8260C/Lab <a href="#">SOP 7</a>	2 x 40-milliliter (ml) volatile vials	40 ml	Hydrochloric to pH <2, cool to <6°C	14 days to analysis
	TPH-GRO (MTBE through Naphthalene)	SW-846 5030/8015B/ Lab <a href="#">SOP 3</a>	2 x 40-ml volatile vials	40 ml	Hydrochloric to pH <2, cool to <6°C	14 days to analysis
	TPH-DRO (C9-C40)	SW-846 3540C, 3550B, or 3570/8015B/Lab <a href="#">SOPs 8, 9, 10, 4</a>	2 x 1-Liter (L) glass	1 L	Cool to <6°C	7 days to extraction; 40 days to analysis
	TCL SVOCs and/or PAHs	SW-846 3510C/8270D, 8270D/SIM/Lab <a href="#">SOPs 10, 4, and 1</a>	3 x 1-L glass	1 L	Cool to <6°C	7 days to extraction; 40 days to analysis
	TCL Pesticides/PCBs	SW-846 3510C/8081B/8082A/Lab <a href="#">SOPs 10, 14, and 2</a>		1 L	Cool to <6°C	7 days to extraction; 40 days to analysis
	TAL Metals	SW-846 3005/3010/6010C/6020/7470B/ Lab <a href="#">SOPs 15, 5, 13, and 6</a>	250-ml plastic	250 ml	Nitric acid to pH <2, cool to <6°C	180 days to analysis for ICP metals; 28 days to analysis for mercury

Matrix	Analytical Group	Analytical and Preparation Method/ SOP Reference <sup>(1)</sup>	Containers (number, size, and type)	Sample volume <sup>(2)</sup> (units)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time <sup>(3)</sup> (preparation/analysis)
Soil	TCL VOCs	SW-846 5035/8260C/Lab <a href="#">SOP 7</a>	2 x 40-ml volatile vials	5 grams (g)	5 ml DI water, cool to <6°C and freeze at < -7° C within 48 hours	14 days to analysis
			1 x 40-ml volatile vial, 1 x 2-ounce (oz) jar	5 g	5 ml methanol, Cool to <6°C	
	TPH-GRO (MTBE through Naphthalene)	SW-846 5035/8015B/ Lab <a href="#">SOP 3</a>	2 x 40-ml volatile vials	5 g	5 ml DI water, cool to <6°C and freeze at < -7° C within 48 hours	14 days to analysis
			1 x 40-ml volatile vial, 1 x 2-oz jar	5 g	5 ml methanol, Cool to <6°C	
	TPH-DRO (C9-C40)	SW-846 3520C or 3510C /8015B/Lab <a href="#">SOPs 3 10, 11.</a>	8-oz wide mouth jar	30 g	Cool to 4°C	14 days to extraction; 40 days to analysis
	TCL SVOCs/PAHs	SW-846 3550B/8270D, 8270D/SIM/Lab <a href="#">SOPs 8, 1, and 4</a>	8-oz wide mouth jar	30 g	Cool to <6°C	14 days to extraction; 40 days to analysis
	TCL Pesticides/PCBs	SW-846 3550B/8081B/8082A/Lab <a href="#">SOPs 10, 14, and 2</a>		30 g	Cool to <6°C	14 days to extraction; 40 days to analysis
	TAL Metals	SW-846 3050B/6010C/6020/7471B/ Lab <a href="#">SOPs 12, 5, 13, and 6</a>	4-oz wide mouth jar	2 g	Cool to <6°C	180 days to analysis for ICP metals; 28 days to analysis for mercury

1 All methods are USEPA SW-846. Refer to the Analytical SOP References table ([Worksheet #10](#)) for Laboratory SOPs.

2 Minimum sample volume or mass requirement.

3 Maximum holding time is calculated from the time the sample is collected to the time the sample is prepared/extracted.

ICP – Inductively coupled plasma.

PAHs – Polycyclic aromatic hydrocarbon.

SIM – Selected Ion Monitoring.

**Table 8-3 -- Field Quality Control Sample Summary Table**

Matrix	Analytical Group	No. of Samples	No. of MS/MSDs <sup>(1)</sup>	No. of Duplicate Samples <sup>(2)</sup>	No. of Trip Blanks <sup>(3)</sup>	No. of Rinsate Blanks <sup>(4)</sup>	Total No. of Samples to Lab
Surface Soil	TPH-DRO (C9-C40)	35	1/1	1	0	1	37
Surface Soil	TPH-GRO (MTBE through naphthalene)	35	1/1	1	3	1	40
Subsurface Soil	TPH-DRO (C9-C40)	105	5/5	5	0	5	115
Subsurface Soil	TPH-GRO (MTBE through naphthalene)	105	5/5	5	10	5	125
Groundwater	VOCs	23	1/1	1	2	1	27
	SVOCs	6	1/1	1	0	1	8
	Naphthalene	23	1/1	1	0	1	25
	Pesticides/PCBs	6	1/1	1	0	1	8
	Metals	23	1/1	1	0	1	25
	TPH-GRO (MTBE through naphthalene)	23	1/1	1	2	1	27
	TPH-DRO (C9-C40)	23	1/1	1	0	1	25

- 1 Although MS/MSDs are not typically considered field QC samples, they are included here because location determination is often established in the field. The MS/MSDs are not included in the total number of samples sent to the laboratory.
- 2 One duplicate sample will be collected for every 20 environmental samples collected.
- 3 One trip blank per VOC and TPH-GRO (MTBE through naphthalene) sample cooler per day will be collected; the quantities identified above are estimates.
- 4 One rinsate blank will be collected for every 20 environmental samples collected.

## 9.0 – Reference Limits and Evaluation Tables

(UFP-QAPP Manual Section 2.8.1 – Worksheet #15)

**Matrix: Soil**  
**Analysis: TPH**

Analyte	CAS Number	PSL (mg/kg)	PSL Reference <sup>(1)</sup>	Project Quantitation Limit Goal (PQLG) (mg/kg)			
					LOQ (mg/kg)	LOD (mg/kg)	DL (mg/kg)
TPH-GRO (MTBE through naphthalene)	--	500	R-DEC/GA	170	2.5	1	0.45
TPH (C9-C40)	--	500	R-DEC/GA	170	7	7	1.3
Total TPH	--	500	R-DEC/GA	170	NA	NA	NA

1 - The PSL references are: R-DEC - Rhode Island Department of Environmental Management (RIDEM) residential direct exposure criterion (RIDEM, 2011); GA - RIDEM GA leachability criterion (RIDEM, 2011). Refer to [Appendix F](#) for further explanation and justification of PSLs.

Bold rows indicate that PSLs are between the laboratory LOQ and the DL. Bold and shaded rows indicate that PSLs are less than the DL. All results will be reported to DLs and any limitations on data use that result from having DLs that are greater than PSLs will be described in the project report. The Partnering Team will describe in the project report any uncertainties that result from having detection limits greater than the PSLs. Particular scrutiny will be applied to these situations when determining whether project objectives have been obtained. Non-detected results greater than PSLs will be evaluated qualitatively in the risk assessment uncertainty section.

Rationale for analyte lists and PALs are described in [Worksheet #5](#).

Soil samples that will be analyzed for TPH are listed in [Table 8-1](#).

**Matrix: Groundwater**  
**Analytical Group: VOCs (SW-846 Method 8260B)**

Analyte	CAS Number	PSL (µg/L)	PSL Reference <sup>(1)</sup>	PQLG (µg/L)			
					LOQ (µg/L)	LOD (µg/L)	DL (µg/L)
1,1,1-Trichloroethane	71-55-6	200	MCL/GA-GW	67	1	0.5	0.5
<b>1,1,2,2-Tetrachloroethane</b>	<b>79-34-5</b>	<b>0.076</b>	<b>T-RSL</b>	<b>0.025</b>	<b>1</b>	<b>0.5</b>	<b>0.42</b>

Analyte	CAS Number	PSL (µg/L)	PSL Reference <sup>(1)</sup>	PQLG (µg/L)			
					LOQ (µg/L)	LOD (µg/L)	DL (µg/L)
1,1,2-trichloro-1,2,2-trifluoroethane (Freon 113)	76-13-1	150	VISL	50	1	1	0.82
<b>1,1,2-Trichloroethane</b>	<b>79-00-5</b>	<b>0.041</b>	<b>T-RSL</b>	<b>0.014</b>	<b>1</b>	<b>1</b>	<b>0.38</b>
1,1-Dichloroethane	75-34-3	2.7	T-RSL	0.90	1	0.5	0.25
1,1-Dichloroethene	75-35-4	7	MCL/GA-GW/GB- GW	2.3	1	0.5	0.39
<b>1,2,3-Trichlorobenzene</b>	<b>87-61-6</b>	<b>0.7</b>	<b>T-RSL</b>	<b>0.23</b>	<b>1</b>	<b>0.5</b>	<b>0.33</b>
<b>1,2,4-Trichlorobenzene</b>	<b>120-82-1</b>	<b>0.40</b>	<b>T-RSL</b>	<b>0.13</b>	<b>1</b>	<b>0.5</b>	<b>0.26</b>
<b>1,2-Dibromo-3-chloropropane (DBCP)</b>	<b>96-12-8</b>	<b>0.00033</b>	<b>T-RSL</b>	<b>0.00011</b>	<b>1</b>	<b>1</b>	<b>0.75</b>
<b>1,2-Dibromoethane (EDB)</b>	<b>106-93-4</b>	<b>0.0075</b>	<b>T-RSL</b>	<b>0.0030</b>	<b>1</b>	<b>0.5</b>	<b>0.5</b>
1,2-Dichlorobenzene	95-50-1	30	T-RSL	10	1	0.5	0.33
<b>1,2-Dichloroethane</b>	<b>107-06-2</b>	<b>0.17</b>	<b>T-RSL</b>	<b>0.057</b>	<b>1</b>	<b>0.5</b>	<b>0.41</b>
<b>1,2-Dichloropropane</b>	<b>78-87-5</b>	<b>0.44</b>	<b>T-RSL</b>	<b>0.15</b>	<b>1</b>	<b>1</b>	<b>0.61</b>
1,3-Dichlorobenzene	541-73-1	600	GA-GW	200	1	0.5	0.29
<b>1,4-Dichlorobenzene</b>	<b>106-46-7</b>	<b>0.48</b>	<b>T-RSL</b>	<b>0.16</b>	<b>1</b>	<b>0.5</b>	<b>0.4</b>
2-Butanone (MEK)	78-93-3	560	T-RSL	187	5	2.5	2.1
<b>2-Hexanone</b>	<b>591-78-6</b>	<b>3.8</b>	<b>T-RSL</b>	<b>1.3</b>	<b>5</b>	<b>2.5</b>	<b>1.7</b>
4-Methyl-2-pentanone (MIBK)	108-10-1	120	T-RSL	40	5	1	0.82
Acetone	67-64-1	1400	T-RSL	470	5	2.5	2.2
<b>Benzene</b>	<b>71-43-2</b>	<b>0.45</b>	<b>T-RSL</b>	<b>0.15</b>	<b>1</b>	<b>0.5</b>	<b>0.33</b>
Bromochloromethane	74-97-5	8.3	T-RSL	2.8	1	0.5	0.43
<b>Bromodichloromethane</b>	<b>75-27-4</b>	<b>0.13</b>	<b>T-RSL</b>	<b>0.043</b>	<b>1</b>	<b>0.5</b>	<b>0.26</b>
Bromoform	75-25-2	9.2	T-RSL	3.1	1	1	0.77
<b>Bromomethane</b>	<b>74-83-9</b>	<b>0.75</b>	<b>T-RSL</b>	<b>0.25</b>	<b>1</b>	<b>1</b>	<b>0.8</b>
Carbon disulfide	75-15-0	81	T-RSL	27	1	0.5	0.34
<b>Carbon tetrachloride</b>	<b>56-23-5</b>	<b>0.41</b>	<b>VISL</b>	<b>0.14</b>	<b>1</b>	<b>1</b>	<b>0.54</b>

Analyte	CAS Number	PSL (µg/L)	PSL Reference <sup>(1)</sup>	PQLG (µg/L)			
					LOQ (µg/L)	LOD (µg/L)	DL (µg/L)
Chlorobenzene	108-90-7	7.8	T-RSL	2.6	1	0.5	0.26
Chloroethane	75-00-3	2100	T-RSL	700	1	0.5	0.48
<b>Chloroform</b>	<b>67-66-3</b>	<b>0.22</b>	<b>T-RSL</b>	<b>0.073</b>	<b>1</b>	<b>0.5</b>	<b>0.33</b>
Chloromethane	74-87-3	19	T-RSL	6.3	1	0.5	0.26
cis-1,2-Dichloroethene	156-59-2	3.6	T-RSL	1.2	1	0.5	0.48
<b>cis-1,3-Dichloropropene</b>	<b>10061-01-5</b>	<b>0.47</b>	<b>T-RSL</b>	<b>0.16</b>	<b>1</b>	<b>0.5</b>	<b>0.45</b>
Cyclohexane	110-82-7	100	VISL	33	1	1	0.71
<b>Dibromochloromethane</b>	<b>124-48-1</b>	<b>0.17</b>	<b>T-RSL</b>	<b>0.057</b>	<b>1</b>	<b>1</b>	<b>0.57</b>
<b>Dichlorodifluoromethane</b>	<b>75-71-8</b>	<b>0.74</b>	<b>VISL</b>	<b>0.25</b>	<b>1</b>	<b>1</b>	<b>0.66</b>
Ethylbenzene	100-41-4	1.5	T-RSL	0.50	1	0.5	0.35
Isopropylbenzene	98-82-8	45	T-RSL	15	1	0.5	0.38
m,p-Xylenes	179601-23-1	19	T-RSL	6.3	1	1	0.77
Methyl acetate	79-20-9	2000	T-RSL	670	1	1	0.29
Methylcyclohexane	108-87-2	NC	None	NA	1	1	0.76
Methylene chloride	75-09-2	5	MCL/GA-GW	1.7	1	0.5	0.41
Methyl-tert-butyl ether	1634-04-4	14	T-RSL	4.7	1	0.5	0.24
o-Xylene	95-47-6	19	T-RSL	6.3	1	0.5	0.36
Styrene	100-42-5	100	MCL/GA-GW	33	1	0.5	0.5
Tetrachloroethene	127-18-4	4.1	T-RSL	1.4	1	1	0.65
Toluene	108-88-3	110	T-RSL	37	1	0.5	0.32
trans-1,2-Dichloroethene	156-60-5	36	T-RSL	12	1	1	0.65
<b>trans-1,3-Dichloropropene</b>	<b>10061-02-6</b>	<b>0.47</b>	<b>T-RSL</b>	<b>0.16</b>	<b>1</b>	<b>0.5</b>	<b>0.48</b>
<b>Trichloroethene</b>	<b>79-01-6</b>	<b>0.28</b>	<b>T-RSL</b>	<b>0.016</b>	<b>1</b>	<b>0.5</b>	<b>0.36</b>
Trichlorofluoromethane	75-69-4	18	VISL	6	1	1	0.54
<b>Vinyl chloride</b>	<b>75-01-4</b>	<b>0.019</b>	<b>T-RSL</b>	<b>0.006</b>	<b>1</b>	<b>0.5</b>	<b>0.5</b>

Analyte	CAS Number	PSL (µg/L)	PSL Reference <sup>(1)</sup>	PQLG (µg/L)			
					LOQ (µg/L)	LOD (µg/L)	DL (µg/L)
Xylenes (total)	1330-20-7	19	T-RSL	6.3	1	1	0.36

1 - The PSL references are: T-RSL – USEPA Regional Screening Level for Tapwater, adjusted to 1/10 of value for noncarcinogens (USEPA, 2014a); MCL – USEPA MCL (USEPA, 2012); GA-GW - RIDEM GA groundwater objective (RIDEM, 2011); GB-GW - RIDEM GB groundwater objective (RIDEM, 2011); VISL - Vapor Intrusion Screening Level (USEPA, 2014b). Refer to [Appendix F](#) for further explanation and justification of PSLs.

Bold rows indicate that PSLs are between the laboratory LOQ and the DL. Bold and shaded rows indicate that PSLs are less than the DL. All results will be reported to DLs and any limitations on data use that result from having DLs that are greater than PSLs will be described in the project report. The Partnering Team will describe in the project report any uncertainties that result from having detection limits greater than the PSLs. Particular scrutiny will be applied to these situations when determining whether project objectives have been obtained. Non-detected results greater than PSLs will be evaluated qualitatively in the risk assessment uncertainty section.

Rationale for analyte lists and PALs are described in [Worksheet #5](#).

Groundwater samples that will be analyzed for VOCs are listed in [Table 8-1](#).

#### Matrix: Groundwater

Analytical Group: SVOCs (Including Low Level PAHs) (SW-846 Method 8270D/8270D SIM\*)

Analyte	CAS Number	PSL (µg/L)	PSL Reference <sup>(1)</sup>	PQLG (µg/L)			
					LOQ (µg/L)	LOD (µg/L)	DL (µg/L)
<b>1,1'-Biphenyl</b>	<b>92-52-4</b>	<b>0.083</b>	T-RSL	<b>0.028</b>	<b>10</b>	<b>2</b>	<b>0.65</b>
<b>1,3-Dinitrobenzene</b>	<b>99-65-0</b>	<b>0.20</b>	T-RSL	<b>0.067</b>	<b>10</b>	<b>0</b>	<b>1</b>
1,4-Dioxane*	123-91-1	0.78	T-RSL	0.26	0.1	0.1	0.07
<b>2,2'-Oxybis(1-chloropropane)</b>	<b>108-60-1</b>	<b>0.36</b>	T-RSL	<b>0.12</b>	<b>10</b>	<b>2</b>	<b>0.78</b>
2,4,5-Trichlorophenol	95-95-4	120	T-RSL	40	20	2	0.26
<b>2,4,6-Trichlorophenol</b>	<b>88-06-2</b>	<b>1.2</b>	T-RSL	<b>0.40</b>	<b>10</b>	<b>2</b>	<b>0.53</b>
<b>2,4-Dichlorophenol</b>	<b>120-83-2</b>	<b>4.6</b>	T-RSL	<b>1.5</b>	<b>10</b>	<b>2</b>	<b>0.57</b>
2,4-Dimethylphenol	105-67-9	36	T-RSL	12	10	2	1.8



Analyte	CAS Number	PSL (µg/L)	PSL Reference <sup>(1)</sup>	PQLG (µg/L)			
					LOQ (µg/L)	LOD (µg/L)	DL (µg/L)
<b>2,4-Dinitrophenol</b>	<b>51-28-5</b>	<b>3.9</b>	<b>T-RSL</b>	<b>1.3</b>	<b>20</b>	<b>10</b>	<b>3.5</b>
<b>2,4-Dinitrotoluene</b>	<b>121-14-2</b>	<b>0.24</b>	<b>T-RSL</b>	<b>0.080</b>	<b>10</b>	<b>2</b>	<b>0.41</b>
<b>2,6-Dinitrotoluene</b>	<b>606-20-2</b>	<b>0.048</b>	<b>T-RSL</b>	<b>0.016</b>	<b>10</b>	<b>2</b>	<b>0.52</b>
2-Chloronaphthalene	91-58-7	75	T-RSL	25	10	2	0.81
<b>2-Chlorophenol</b>	<b>95-57-8</b>	<b>9.1</b>	<b>T-RSL</b>	<b>3.0</b>	<b>10</b>	<b>2</b>	<b>0.61</b>
2-Methylphenol (o-Cresol)	95-48-7	93	T-RSL	31	10	2	0.96
<b>2-Nitroaniline</b>	<b>88-74-4</b>	<b>19</b>	<b>T-RSL</b>	<b>6.3</b>	<b>20</b>	<b>2</b>	<b>0.71</b>
2-Nitrophenol	88-75-5	NC	None	NA	10	2	0.6
<b>3,3'-Dichlorobenzidine</b>	<b>91-94-1</b>	<b>0.12</b>	<b>T-RSL</b>	<b>0.040</b>	<b>10</b>	<b>10</b>	<b>1.7</b>
3-Methylphenol (m-Cresol)	108-39-4	93	T-RSL	31			
<b>3-Nitroaniline</b>	<b>99-09-2</b>	<b>3.8</b>	<b>T-RSL</b>	<b>1.3</b>	<b>20</b>	<b>2</b>	<b>0.97</b>
<b>4,6-Dinitro-2-methylphenol</b>	<b>534-52-1</b>	<b>0.15</b>	<b>T-RSL</b>	<b>0.05</b>	<b>20</b>	<b>2</b>	<b>0.79</b>
4-Bromophenyl phenyl ether	101-55-3	NC	None	NA	10	2	0.54
4-Chloro-3-methyl phenol	59-50-7	140	T-RSL	47	10	2	0.6
<b>4-Chloroaniline</b>	<b>106-47-8</b>	<b>0.36</b>	<b>T-RSL</b>	<b>0.12</b>	<b>10</b>	<b>2</b>	<b>2</b>
4-Chlorophenyl phenyl ether	7005-72-3	NC	None	NA	10	2	0.41
4-Methylphenol (p-Cresol)	106-44-5	190	T-RSL	63	10	2	1.4
<b>4-Nitroaniline</b>	<b>100-01-6</b>	<b>3.8</b>	<b>T-RSL</b>	<b>1.3</b>	<b>20</b>	<b>2</b>	<b>0.96</b>
4-Nitrophenol	100-02-7	NC	None	NA	20	2	0.53
Acetophenone	98-86-2	190	T-RSL	63	10	2	0.51
<b>Atrazine</b>	<b>1912-24-9</b>	<b>0.30</b>	<b>T-RSL</b>	<b>0.10</b>	<b>10</b>	<b>2</b>	<b>1.3</b>
Benzaldehyde	100-52-7	190	T-RSL	63	10	2	0.51
<b>Bis(2-chloroethoxy)methane</b>	<b>111-91-1</b>	<b>5.9</b>	<b>T-RSL</b>	<b>2.0</b>	<b>10</b>	<b>2</b>	<b>1.1</b>
<b>Bis(2-chloroethyl)ether</b>	<b>111-44-4</b>	<b>0.014</b>	<b>T-RSL</b>	<b>0.0047</b>	<b>10</b>	<b>2</b>	<b>0.75</b>
<b>Bis(2-ethylhexyl)phthalate</b>	<b>117-81-7</b>	<b>5.6</b>	<b>T-RSL</b>	<b>1.9</b>	<b>10</b>	<b>2</b>	<b>1.3</b>

Analyte	CAS Number	PSL (µg/L)	PSL Reference <sup>(1)</sup>	PQLG (µg/L)			
					LOQ (µg/L)	LOD (µg/L)	DL (µg/L)
Butyl benzyl phthalate	85-68-7	16	T-RSL	5.3	10	2	0.32
Caprolactam	105-60-2	990	T-RSL	330	10	10	1.1
Carbazole	86-74-8	NC	None	NA	10	2	0.64
<b>Dibenzofuran</b>	<b>132-64-9</b>	<b>0.79</b>	<b>T-RSL</b>	<b>0.26</b>	<b>10</b>	<b>2</b>	<b>0.52</b>
Diethyl phthalate	84-66-2	1500	T-RSL	500	10	2	0.45
Dimethyl phthalate	131-11-3	NC	None	NA	10	2	0.37
Di-n-butyl phthalate	84-74-2	90	T-RSL	30	10	2	0.48
Di-n-octyl phthalate	117-84-0	20	T-RSL	6.7	10	2	0.47
<b>Hexachlorobenzene</b>	<b>118-74-1</b>	<b>0.049</b>	<b>T-RSL</b>	<b>0.016</b>	<b>10</b>	<b>2</b>	<b>0.44</b>
<b>Hexachlorobutadiene</b>	<b>87-68-3</b>	<b>0.30</b>	<b>T-RSL</b>	<b>0.10</b>	<b>10</b>	<b>2</b>	<b>0.75</b>
<b>Hexachlorocyclopentadiene</b>	<b>77-47-4</b>	<b>3.1</b>	<b>T-RSL</b>	<b>1.0</b>	<b>10</b>	<b>10</b>	<b>1</b>
<b>Hexachloroethane</b>	<b>67-72-1</b>	<b>0.69</b>	<b>T-RSL</b>	<b>0.23</b>	<b>10</b>	<b>2</b>	<b>0.55</b>
Isophorone	78-59-1	78	T-RSL	26	10	2	0.47
<b>Nitrobenzene</b>	<b>98-95-3</b>	<b>0.14</b>	<b>T-RSL</b>	<b>0.047</b>	<b>10</b>	<b>10</b>	<b>1.6</b>
<b>N-Nitrosodi-n-propylamine</b>	<b>621-64-7</b>	<b>0.011</b>	<b>T-RSL</b>	<b>0.0037</b>	<b>10</b>	<b>2</b>	<b>0.63</b>
N-Nitrosodiphenylamine	86-30-6	12	T-RSL	4.0	10	2	1.1
<b>Pentachlorophenol</b>	<b>87-86-5</b>	<b>0.040</b>	<b>T-RSL</b>	<b>0.013</b>	<b>20</b>	<b>10</b>	<b>1.7</b>
Phenol	108-95-2	580	T-RSL	193	10	2	0.75
PAHs							
2-Methylnaphthalene*	91-57-6	3.6	T-RSL	1.2	0.1	0.1	0.018
Acenaphthene*	83-32-9	53	T-RSL	18	0.1	0.1	0.019
Acenaphthylene*	208-96-8	53	T-RSL	18	0.1	0.1	0.017
Anthracene*	120-12-7	180	T-RSL	60	0.1	0.1	0.017
<b>Benzo(a)anthracene*</b>	<b>56-55-3</b>	<b>0.034</b>	<b>T-RSL</b>	<b>0.011</b>	<b>0.1</b>	<b>0.1</b>	<b>0.042</b>
<b>Benzo(a)pyrene*</b>	<b>50-32-8</b>	<b>0.0034</b>	<b>T-RSL</b>	<b>0.0011</b>	<b>0.1</b>	<b>0.1</b>	<b>0.017</b>

Analyte	CAS Number	PSL (µg/L)	PSL Reference <sup>(1)</sup>	PQLG (µg/L)			
					LOQ (µg/L)	LOD (µg/L)	DL (µg/L)
<b>Benzo(b)fluoranthene*</b>	<b>205-99-2</b>	<b>0.034</b>	<b>T-RSL</b>	<b>0.011</b>	<b>0.1</b>	<b>0.1</b>	<b>0.056</b>
Benzo(g,h,i)perylene*	191-24-2	12	T-RSL	4	0.1	0.1	0.021
Benzo(k)fluoranthene*	207-08-9	0.34	T-RSL	0.11	0.1	0.1	0.02
Chrysene*	218-01-9	3.4	T-RSL	1.1	0.1	0.1	0.073
<b>Dibenzo(a,h)anthracene*</b>	<b>53-70-3</b>	<b>0.0034</b>	<b>T-RSL</b>	<b>0.0011</b>	<b>0.1</b>	<b>0.1</b>	<b>0.018</b>
Fluoranthene*	206-44-0	80	T-RSL	27	0.1	0.1	0.019
Fluorene*	86-73-7	29	T-RSL	9.7	0.1	0.1	0.017
<b>Indeno(1,2,3-c,d)pyrene*</b>	<b>193-39-5</b>	<b>0.034</b>	<b>T-RSL</b>	<b>0.011</b>	<b>0.1</b>	<b>0.1</b>	<b>0.019</b>
Naphthalene*	91-20-3	0.17	T-RSL	0.057	0.1	0.1	0.05
Phenanthrene*	85-01-8	12	T-RSL	4	0.1	0.1	0.019
Pyrene*	129-00-0	12	T-RSL	4	0.1	0.1	0.016

\*PAHs and 1,4-dioxane are analyzed by Selected Ion Monitoring (SIM).

1 - The PSL reference is: T-RSL – USEPA Regional Screening Level for Tapwater, adjusted to 1/10 of value for noncarcinogens (USEPA, 2014a).

Refer to [Appendix F](#) for further explanation and justification of PSLs.

Bold rows indicate that PSLs are between the laboratory LOQ and the DL. Bold and shaded rows indicate that PSLs are less than the DL. All results will be reported to DLs and any limitations on data use that result from having DLs that are greater than PSLs will be described in the project report. The Partnering Team will describe in the project report any uncertainties that result from having detection limits greater than the PSLs. Particular scrutiny will be applied to these situations when determining whether project objectives have been obtained. Non-detected results greater than PSLs will be evaluated qualitatively in the risk assessment uncertainty section.

Rationale for analyte lists and PALs are described in [Worksheet #5](#).

Groundwater samples that will be analyzed for SVOCs are listed in [Table 8-1](#).

**Matrix: Groundwater**

**Analysis: PCBs as Aroclors by SW-846 Method 8082A**

Analyte	CAS Number	PSL (µg/L)	PSL Reference <sup>(1)</sup>	PQLG (µg/L)			
					LOQ (µg/L)	LOD (µg/L)	DL (µg/L)
Aroclor-1016	12674-11-2	0.14	T-RSL	0.047	0.2	0.05	0.0238
Aroclor-1221	11104-28-2	0.0046	T-RSL	0.0015	0.2	0.1	0.019
Aroclor-1232	11141-16-5	0.0046	T-RSL	0.0015	0.2	0.05	0.037
Aroclor-1242	53469-21-9	0.039	T-RSL	0.013	0.2	0.05	0.006
Aroclor-1248	12672-29-6	0.039	T-RSL	0.013	0.2	0.05	0.0126
Aroclor-1254	11097-69-1	0.039	T-RSL	0.013	0.2	0.05	0.0408
Aroclor-1260	11096-82-5	0.039	T-RSL	0.013	0.2	0.05	0.021

1 - The PSL reference is: T-RSL – USEPA Regional Screening Level for Tapwater, adjusted to 1/10 of value for noncarcinogens (USEPA, 2014a).

Refer to [Appendix F](#) for further explanation and justification of PSLs.

Bold rows indicate that PSLs are between the laboratory LOQ and the DL. Bold and shaded rows indicate that PSLs are less than the DL. All results will be reported to DLs and any limitations on data use that result from having DLs that are greater than PSLs will be described in the project report. The Partnering Team will describe in the project report any uncertainties that result from having detection limits greater than the PSLs. Particular scrutiny will be applied to these situations when determining whether project objectives have been obtained. Non-detected results greater than PSLs will be evaluated qualitatively in the risk assessment uncertainty section.

Rationale for analyte lists and PALs are described in [Worksheet #5](#).

Groundwater samples that will be analyzed for PCBs are listed in [Table 8-1](#).

**Matrix: Groundwater**

**Analysis: TCL Pesticides by SW-846 Method 8081B**

Analyte	CAS Number	PSL (µg/L)	PSL Reference <sup>(1)</sup>	PQLG (µg/L)			
					LOQ (µg/L)	LOD (µg/L)	DL (µg/L)
4,4'-DDD	72-54-8	0.031	T-RSL	0.009	0.1	0.025	0.0064
4,4'-DDE	72-55-9	0.23	T-RSL	0.077	0.1	0.025	0.0056
4,4'-DDT	50-29-3	0.23	T-RSL	0.077	0.1	0.025	0.007

Analyte	CAS Number	PSL (µg/L)	PSL Reference <sup>(1)</sup>	PQLG (µg/L)			
					LOQ (µg/L)	LOD (µg/L)	DL (µg/L)
<b>Aldrin</b>	<b>309-00-2</b>	<b>0.0046</b>	<b>T-RSL</b>	<b>0.0015</b>	<b>0.05</b>	<b>0.0125</b>	<b>0.0043</b>
<b>Alpha-BHC</b>	<b>319-84-6</b>	<b>0.0071</b>	<b>T-RSL</b>	<b>0.0024</b>	<b>0.05</b>	<b>0.0125</b>	<b>0.0018</b>
Alpha-Chlordane	5103-71-9	0.22	T-RSL	0.073	0.05	0.0125	0.0024
<b>Beta-BHC</b>	<b>319-85-7</b>	<b>0.025</b>	<b>T-RSL</b>	<b>0.0083</b>	<b>0.05</b>	<b>0.0125</b>	<b>0.002</b>
<b>Delta-BHC</b>	<b>319-86-8</b>	<b>0.0071</b>	<b>T-RSL</b>	<b>0.0024</b>	<b>0.05</b>	<b>0.0125</b>	<b>0.0027</b>
<b>Dieldrin</b>	<b>60-57-1</b>	<b>0.0017</b>	<b>T-RSL</b>	<b>0.00057</b>	<b>0.1</b>	<b>0.025</b>	<b>0.0056</b>
Endosulfan I	959-98-8	10	T-RSL	3.3	0.05	0.0125	0.0029
Endosulfan II	33213-65-9	10	T-RSL	3.3	0.1	0.025	0.0031
Endosulfan Sulfate	1031-07-8	10	T-RSL	3.3	0.1	0.025	0.0045
Endrin	72-20-8	0.23	T-RSL	0.077	0.1	0.025	0.0035
Endrin Aldehyde	7421-93-4	0.23	T-RSL	0.077	0.1	0.025	0.015
Endrin Ketone	53494-70-5	0.23	T-RSL	0.077	0.1	0.025	0.0046
<b>Gamma-BHC (Lindane)</b>	<b>58-89-9</b>	<b>0.041</b>	<b>T-RSL</b>	<b>0.014</b>	<b>0.05</b>	<b>0.0125</b>	<b>0.0019</b>
Gamma-Chlordane	5103-74-2	0.22	T-RSL	0.073	0.05	0.0125	0.0026
<b>Heptachlor</b>	<b>76-44-8</b>	<b>0.0020</b>	<b>T-RSL</b>	<b>0.00067</b>	<b>0.05</b>	<b>0.0125</b>	<b>0.0039</b>
<b>Heptachlor Epoxide</b>	<b>1024-57-3</b>	<b>0.0038</b>	<b>T-RSL</b>	<b>0.0013</b>	<b>0.05</b>	<b>0.0125</b>	<b>0.0028</b>
Methoxychlor	72-43-5	3.7	T-RSL	1.2	0.5	0.125	0.031
<b>Toxaphene</b>	<b>8001-35-2</b>	<b>0.015</b>	<b>T-RSL</b>	<b>0.0050</b>	<b>5</b>	<b>0.5</b>	<b>0.14</b>

1 - The PSL reference is: T-RSL – USEPA Regional Screening Level for Tapwater, adjusted to 1/10 of value for noncarcinogens (USEPA, 2014a). Refer to [Appendix F](#) for further explanation and justification of PSLs.

Bold rows indicate that PSLs are between the laboratory LOQ and the DL. Bold and shaded rows indicate that PSLs are less than the DL. All results will be reported to DLs and any limitations on data use that result from having DLs that are greater than PSLs will be described in the project report. The Partnering Team will describe in the project report any uncertainties that result from having detection limits greater than the PSLs. Particular scrutiny will be applied to these situations when determining whether project objectives have been obtained. Non-detected results greater than PSLs will be evaluated qualitatively in the risk assessment uncertainty section.

Rationale for analyte lists and PALs are described in [Worksheet #5](#).

Groundwater samples that will be analyzed for pesticides are listed in [Table 8-1](#).

**Matrix: Groundwater**  
**Analytical Group: Metals (SW-846 Methods 6010B/7470B\*)**

Analyte	CAS Number	PSL (µg/L)	PSL Reference <sup>(1)</sup>	PQLG (µg/L)			
					LOQ (µg/L)	LOD (µg/L)	DL (µg/L)
Aluminum	7429-90-5	2000	T-RSL	670	200	100	66
<b>Antimony</b>	<b>7440-36-0</b>	<b>0.78</b>	<b>T-RSL</b>	<b>0.26</b>	<b>20</b>	<b>15</b>	<b>9.3</b>
Barium	7440-39-3	380	T-RSL	130	200	3	1.1
<b>Beryllium</b>	<b>7440-41-7</b>	<b>2.5</b>	<b>T-RSL</b>	<b>0.83</b>	<b>5</b>	<b>1</b>	<b>0.26</b>
Calcium	7440-70-2	NC	None	NA	800	300	110
Copper	7440-50-8	80	T-RSL	27	30	5	3.6
Iron	7439-89-6	1400	T-RSL	470	200	50	31
Lead	7439-92-1	15	T-RSL	5	10	5	4.2
Magnesium	7439-95-4	NC	None	NA	500	100	76
<b>Manganese</b>	<b>7439-96-5</b>	<b>43</b>	<b>T-RSL</b>	<b>14</b>	<b>50</b>	<b>15</b>	<b>10</b>
Mercury	7439-97-6	0.063	T-RSL	0.021	0.033	0.02	0.0021
<b>Nickel</b>	<b>7440-02-0</b>	<b>39</b>	<b>T-RSL</b>	<b>13</b>	<b>50</b>	<b>1</b>	<b>0.85</b>
Potassium	7440-09-7	NC	None	NA	1000	100	76
<b>Silver</b>	<b>7440-22-4</b>	<b>9.4</b>	<b>T-RSL</b>	<b>3.1</b>	<b>30</b>	<b>10</b>	<b>6.9</b>
Sodium	7440-23-5	NC	None	NA	1000	100	29
<b>Vanadium</b>	<b>7440-62-2</b>	<b>8.6</b>	<b>T-RSL</b>	<b>2.9</b>	<b>50</b>	<b>2</b>	<b>1.1</b>
Zinc	7440-66-6	600	T-RSL	200	50	7.5	4.9

\*for Metals analyzed by ICP-MS--see below

**Matrix: Groundwater**  
**Analytical Group: Metals (SW-846 Methods 6020A\*)**

Analyte	CAS Number	PSL (µg/L)	PSL Reference <sup>(1)</sup>	PQLG (µg/L)			
					LOQ (µg/L)	LOD (µg/L)	DL (µg/L)
<b>Arsenic *</b>	<b>7440-38-2</b>	<b>0.052</b>	<b>T-RSL</b>	<b>0.017</b>	<b>2</b>	<b>0.375</b>	<b>0.19</b>
<b>Cadmium *</b>	<b>7440-43-9</b>	<b>0.92</b>	<b>T-RSL</b>	<b>0.31</b>	<b>1</b>	<b>0.15</b>	<b>0.084</b>
<b>Chromium *</b>	<b>7440-47-3</b>	<b>0.035</b>	<b>T-RSL</b>	<b>0.012</b>	<b>2</b>	<b>0.25</b>	<b>0.16</b>
<b>Cobalt *</b>	<b>7440-48-4</b>	<b>0.60</b>	<b>T-RSL</b>	<b>0.20</b>	<b>1</b>	<b>0.05</b>	<b>0.024</b>
Selenium *	7782-49-2	10	T-RSL	3.3	5	0.25	0.15
<b>Thallium *</b>	<b>7440-28-0</b>	<b>0.020</b>	<b>T-RSL</b>	<b>0.0067</b>	<b>1</b>	<b>0.075</b>	<b>0.048</b>

1 - The PSL reference is: T-RSL – USEPA Regional Screening Level for Tapwater, adjusted to 1/10 of value for noncarcinogens (USEPA, 2014a).  
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Bold rows indicate that PSLs are between the laboratory LOQ and the DL. Bold and shaded rows indicate that PSLs are less than the DL. All results will be reported to DLs and any limitations on data use that result from having DLs that are greater than PSLs will be described in the project report. The Partnering Team will describe in the project report any uncertainties that result from having detection limits greater than the PSLs. Particular scrutiny will be applied to these situations when determining whether project objectives have been obtained. Non-detected results greater than PSLs will be evaluated qualitatively in the risk assessment uncertainty section.

Rationale for analyte lists and PALs are described in [Worksheet #5](#).

Groundwater samples that will be analyzed for metals are listed in [Table 8-1](#).

**Matrix: Groundwater**  
**Analysis: TPH**

Analyte	CAS Number	PSL (µg/L)	PSL Reference <sup>(1)</sup>	PQLG (µg/L)			
					LOQ (µg/L)	LOD (µg/L)	DL (µg/L)
TPH-GRO (MTBE through naphthalene)	--	NC	None	NA	100	20	5.8
TPH-DRO (C9-C40)	--	NC	None	NA	0.2	0.2	0.018
Total TPH	--	NC	None	NA	NA	NA	NA

1 - No PSLs are available for TPH in groundwater.

Bold rows indicate that PSLs are between the laboratory LOQ and the DL. Bold and shaded rows indicate that PSLs are less than the DL. All results will be reported to DLs and any limitations on data use that result from having DLs that are greater than PSLs will be described in the project report. The Partnering Team will describe in the project report any uncertainties that result from having detection limits greater than the PSLs. Particular scrutiny will be applied to these situations when determining whether project objectives have been obtained.

Rationale for analyte lists and PALs are described in [Worksheet #5](#).

Groundwater samples that will be analyzed for TPH are listed in [Table 8-1](#).



## 10.0 – Analytical SOP Reference Table

(UFP-QAPP Manual Section 3.2.1 – Worksheet #23)

Lab SOP Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)	Variance from DOD Quality Systems Manual (QSM)? (Y/N)
1	70.0033: Semivolatiles by Method 8270D SIM, Rev 7, 8/11	Definitive	Aqueous/Soil/PAHs (SIM)	GC/MS	Spectrum	N	N
2	60.0003: PCBs by Method 8082, Rev. 10, 4/11	Definitive	Aqueous/Soil/PCB Aroclors	GC/ECD	Spectrum	N	N
3	60.0050: TPH by GC/FID using Method SW-846 8015B, Rev. 4, 6/13	Definitive	Aqueous/Soil/TPH-DRO, TPH-GRO	GC/FID	Spectrum	Y <sup>(1)</sup>	NA
4	70.0011: Semivolatiles by Method 8270D, Rev 11, 7/11	Definitive	Aqueous/Soil/SVOCs	GC/MS	Spectrum	N	N
5	100.0111: Metals by Method 6010C, Rev 13, 12/10	Definitive	Aqueous/Soil/ICP Metals	ICP-AES	Spectrum	N	N
6	100.0012: Mercury by Method 7470A/7471B, Rev 10, 6/10	Definitive	Aqueous/Soil/Mercury	CVAA	Spectrum	N	N
7	90.0012, Volatile Organic Compounds by Method 8260C, Rev 13, 9/12	Definitive	Aqueous/Soil/VOCs	GC/MS	Spectrum	N	N
8	50.0052, Organic Preparation of Soil Samples by Sonication, Method 3550B, Rev 4, 8/13	Definitive	Soil/SVOCs, PAHs, Pesticides, PCBs	NA	Spectrum	N	N
9	50.0053, Organic Preparation of Soil Samples by Soxhlet, Method 3540C, Rev 3, 2/10	Definitive	Soil/SVOCs, PAHs, Pesticides, PCBs	NA	Spectrum	N	N
10	50.0050, Organic Preparation of Aqueous Samples by continuous liquid-liquid extraction, Method 3520C, Rev 6, 4/11	Definitive	Aqueous/SVOCs, PAHs, Pesticides, PCBs	NA	Spectrum	N	N
11	50.0051, Organic Preparation of Aqueous Samples by separatory funnel extraction, Method 3510C, Rev 2, 2/10	Definitive	Aqueous/SVOCs, PAHs, Pesticides, PCBs	NA	Spectrum	N	N
12	100.0104, Sample Preparation of Soils by Acid Digestion for ICP, Method 3050B, Rev 8, 3/10	Definitive	Soil/ICP Metals	NA	Spectrum	N	N

Lab SOP Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)	Variance from DOD Quality Systems Manual (QSM)? (Y/N)
13	100.0110: Metals by Method 6020A, Rev 3, 12/13	Definitive	Aqueous/Soil/ICP-MS Metals	ICP-MS	Spectrum	N	N
14	60.0006: Pesticides by Method 8081B, Rev. 10, 4/11	Definitive	Aqueous/Soil /Pesticides	GC/ECD	Spectrum	N	N
15	100.0003, Sample Preparation of Waters by Acid Digestion for ICP, ICP/MS Method 3005/3010, Rev 8, 2/10	Definitive	Aqueous /ICP, ICP-MS Metals	NA	Spectrum	N	N

A copy of Spectrum DOD ELAP accreditation is included in [Appendix E](#).

1 Modification to quantification range changed from C9-C36 to C9-C40; GRO range from MTBE through naphthalene.

AES - Atomic emission spectroscopy  
CVAA - Cold vapor atomic absorption  
GC/EDC - Gas chromatography/electron capture detector  
GC/FID - Gas chromatography/flame ionization detector  
GC/MS - Gas chromatography/mass spectrometry  
ICP-MS - Inductively Coupled Plasma/Mass Spectroscopy  
NA - Not applicable

## 11.0 – Laboratory QC Samples Tables

(UFP-QAPP Manual Section 3.4 – Worksheet #28)

<b>Matrix</b>	Aqueous/Soil					
<b>Analytical Group</b>	TCL VOCs					
<b>Analytical Method/ SOP Reference</b>	SW-846 8260C/Lab SOP 7					
QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	MPC
Method Blank	One per preparation batch of 20 or fewer samples of similar matrix.	No target analytes >one half of LOQ except for common lab contaminants not > LOQ.	Investigate source of contamination. Rerun method blank. No samples may be run until an acceptable method blank has been run.	Analyst, Supervisor	Accuracy/Bias/Contamination	Same as Method/SOP QC Acceptance Limits.
MS	One per batch of 20 or fewer samples of similar matrix.	%R within DoD Quality Systems Manual (QSM) limits.	If recoveries are outside limits and surrogate and LCS criteria are met, note in narrative. If both the LCS and MS/MSD are unacceptable reprepare the samples and QC. Check standard prepare. Flag outliers with * on Form 3.	Analyst, Supervisor	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
MSD	One per batch of 20 or fewer samples of similar matrix.	%R within DoD QSM limits; RPD must be > 40%.	Same as MS.	Analyst, Supervisor	Accuracy/Bias and Precision	Same as Method/SOP QC Acceptance Limits.
LCS/LCS Duplicate (LCSD)	One per batch of 20 or fewer samples of similar matrix. Include LCSD if preparation batch does not include MS/MSD.	%R within DoD QSM limits; RPD must be > 40%.	Reanalyze once. If the LCS recoveries are high but the sample results are <LOQ narrate. Flag with * on Form 3.	Analyst, Supervisor	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.

<b>Matrix</b>	Aqueous/Soil					
<b>Analytical Group</b>	TCL VOCs					
<b>Analytical Method/ SOP Reference</b>	SW-846 8260C/Lab <a href="#">SOP 7</a>					
QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	MPC
Internal Standard (IS)	Each field and QC sample.	IS area -50% to +100% compared to IS from continuing calibration verification (CCV); IS Retention Time (RT) window $\pm$ 0.5 minute compared to CCV RT.	Reanalyze affected samples. If similar results, report both runs. Flag outliers with an * on Form 8.	Analyst, Supervisor	Accuracy	Same as Method/SOP QC Acceptance Limits.
Surrogates	Four per sample.	%Rs must be within: 1,2-Dichloroethane-d4 88-110% Soil 70-120% Water Bromofluorobenzene 85-170% Soil 75-120% Water Dibromofluoromethane 76-128% Soil 85-115% Water Toluene-d8 85-115% Soil 85-120% Water 1 out allowed.	If sample volume is available, reanalyze. Report both if second successful analysis is outside holding time or both fail QC criteria. Flag with * on Form 2.	Analyst, Supervisor	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
Temperature Blank	One per cooler.	<6° C.	Laboratory will notify Tetra Tech Project Chemist of temperatures outside criteria. Tetra Tech Project Chemist will respond as to whether to proceed with analysis.	Analyst, Supervisor	Accuracy/Bias/ Representative- ness	Same as Method/SOP QC Acceptance Limits.
Results between DL and LOQ	NA	Apply "J" qualifier to results between DL and LOQ.	NA	Analyst, Supervisor	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.

Matrix	Soil and groundwater					
Analytical Group	TPH-GRO (MTBE through Naphthalene)					
Analytical Method/ SOP Reference	SW846 8015B/ Lab <a href="#">SOP 3</a>					
QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	MPC
Method Blank	One per preparation batch of twenty or fewer samples of similar matrix.	No target analytes >one half of LOQ.	Investigate source of contamination. Rerun method blank. Re-extract associated batch of samples unless not detected for the contaminant.	Analyst, Supervisor	Accuracy/Bias, Contamination	Same as Method/SOP QC Acceptance Limits.
LCS	One per preparation batch of twenty or fewer samples of similar matrix.	%R must be between for aqueous and soil samples 80-120%.	Reanalyze once. If the LCS recoveries are high but the sample results are <LOQ, narrate. Flag with * on Form 3.	Analyst, Supervisor	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
LCSD	One per preparation batch of twenty or fewer samples of similar matrix.	Same as LCS. RPD $\leq$ 20% for aqueous and soil samples.	Reanalyze once. If the LCS recoveries are within QC limits, narrate. Flag with * on Form 3.	Analyst, Supervisor	Accuracy/Bias, Precision	Same as Method/SOP QC Acceptance Limits.
MS	One per preparation batch of twenty or fewer samples of similar matrix.	%R must be between 60-140% for aqueous and soil samples.	If recoveries are outside limits and LCS criteria are met, note in narrative. If both the LCS and MS/MSD are unacceptable check standard prep. Speak with PM regarding further action. Flag outliers with * on Form 3.	Analyst, Supervisor	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
MSD	One per preparation batch of twenty or fewer samples of similar matrix.	Same as MS. RPD $\leq$ 30% for aqueous and soil samples.	Same as MS.	Analyst, Supervisor	Accuracy/Bias, Precision	Same as Method/SOP QC Acceptance Limits.
Surrogates	1 per sample.	Bromo-fluorobenzene, %R must be between 87-112% for aqueous samples and 79-118% for soil samples.	Unless obvious chromatographic interference, if sample volume available, re-extract. Report both if second successful analysis is outside Holding Time or both fail QC criteria. Flag with * on Form 2.	Analyst, Supervisor	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.

Matrix	Soil and groundwater					
Analytical Group	TPH-GRO (MTBE through Naphthalene)					
Analytical Method/ SOP Reference	SW846 8015B/ Lab <a href="#">SOP 3</a>					
QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	MPC
Temperature Blank	One per cooler.	0 to 6.	Laboratory will notify Tetra Tech PM of temperatures outside criteria. Tetra Tech PM will respond whether to proceed with analysis.	Analyst, Supervisor	Accuracy/bias/ representativeness	Same as Method/SOP QC Acceptance Limits.

<b>Matrix</b>	Aqueous/Soil					
<b>Analytical Group</b>	TCL SVOCs, PAHs					
<b>Analytical Method/ SOP Reference</b>	SW-846 8270D/Lab SOP 1,4					
QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	MPC
Method Blank	One per preparation batch of 20 or fewer samples of similar matrix.	No target analytes >one half of LOQ except for common lab contaminants not > LOQ.	Investigate source of contamination. Rerun method blank. No samples may be run until an acceptable method blank has been run.	Analyst, Supervisor	Accuracy/Bias-Contamination	Same as Method/SOP QC Acceptance Limits.
MS	One per batch of 20 or fewer samples of similar matrix.	%R within DoD QSM limits.	If recoveries are outside limits and surrogate and LCS criteria are met, note in narrative. If both the LCS and MS/MSD are unacceptable reprepare the samples and QC. Check standard preparation. Flag outliers with * on Form 3.	Analyst, Supervisor	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
MSD	One per batch of 20 or fewer samples of similar matrix.	%R within DoD QSM limits; RPD must be <40%.	Same as MS.	Analyst, Supervisor	Accuracy/Bias and Precision	Same as Method/SOP QC Acceptance Limits.
LCS/LCSD	One per batch of 20 or fewer samples of similar matrix. Include LCSD if preparation batch does not include MS/MSD.	%R within DoD QSM limits; RPD must be <40%.	Reanalyze once. If the LCS recoveries are high but the sample results are <LOQ narrate. Flag with * on Form 3.	Analyst, Supervisor	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
IS	Each field and QC sample.	IS area -50% to +100% compared to IS from CCV; IS RT window $\pm$ 0.5 minutes compared to CCV RT.	Reanalyze affected samples. If similar results, report both runs. Flag outliers with an * on Form 8.	Analyst, Supervisor	Accuracy	Same as Method/SOP QC Acceptance Limits.

<b>Matrix</b>	Aqueous/Soil					
<b>Analytical Group</b>	TCL SVOCs, PAHs					
<b>Analytical Method/ SOP Reference</b>	SW-846 8270D/Lab SOP 1,4					
QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	MPC
Surrogates	Six per sample (full scan), one per sample (SIM).	Full scan: %Rs must be within: 2,4,6-Tribromophenol 35-125% Soil, 40-125% Water 2-Fluorobiphenyl 45-105% Soil, 50-110% Water 2-Fluorophenol 35-105% Soil, 20-110% Water Nitrobenzene-d5 35-100% Soil, 40-110% Water Phenol-d5 40-100% Soil, 10-115% Water Terphenyl-d14 30-125% Soil, 50-135% Water SIM: Benzo(e)pyrene-d12, 45% - 135% Soil, 80-120% Water.	If sample volume available, re- extract. Report both if second successful analysis is outside holding time or both fail QC criteria. Flag with * on Form 2.	Analyst, Supervisor	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
Temperature Blank	One per cooler.	<6° C.	Laboratory will notify Tetra Tech Project Chemist of temperatures outside criteria. Tetra Tech Project Chemist will respond as to whether to proceed with analysis.	Analyst, Supervisor	Accuracy/Bias/ Representative- ness	Same as Method/SOP QC Acceptance Limits.
Results between DL and LOQ	NA	Apply "J" qualifier to results between DL and LOQ.	NA	Analyst, Supervisor	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.



<b>Matrix</b>	Aqueous/Soil					
<b>Analytical Group</b>	TPH-DRO (C9-C40)					
<b>Analytical Method/ SOP Reference</b>	SW-846 8015B/Lab SOP 3					
<b>QC Sample</b>	<b>Frequency/ Number</b>	<b>Method/SOP QC Acceptance Limits</b>	<b>Corrective Action</b>	<b>Person(s) Responsible for Corrective Action</b>	<b>DQI</b>	<b>MPC</b>
Method Blank	One per preparation batch of 20 or fewer samples of similar matrix.	No target analytes >one half of LOQ.	Investigate source of contamination. Rerun method blank. Re-extract associated batch of samples unless ND for the contaminant.	Analyst, Supervisor	Accuracy/Bias, Contamination	Same as Method/SOP QC Acceptance Limits.
LCS	One per preparation batch of 20 or fewer samples of similar matrix.	%Rs must be within: 60-140%.	Reanalyze once. If the LCS recoveries are high but the sample results are <LOQ narrate. Flag with * on Form 3.	Analyst, Supervisor	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
LCSD	One per preparation batch of 20 or fewer samples of similar matrix.	%Rs must be within: 60-140% RPD ≤ 20%.	Reanalyze once. If the LCS recoveries are within QC limits, narrate. Flag with * on Form 3.	Analyst, Supervisor	Accuracy/Bias, Precision	Same as Method/SOP QC Acceptance Limits.
MS	One per preparation batch of 20 or fewer samples of similar matrix.	%Rs must be within: 50-150%.	If recoveries are outside limits and surrogate and LCS criteria are met, note in narrative. If both the LCS and MS/MSD are unacceptable check standard prep. Speak with PM regarding further action. Flag outliers with * on Form 3.	Analyst, Supervisor	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
MSD	One per preparation batch of 20 or fewer samples of similar matrix.	%Rs must be within: 50-150 RPD must be ≤ 30.	Same as MS.	Analyst, Supervisor	Accuracy/Bias, Precision	Same as Method/SOP QC Acceptance Limits.

<b>Matrix</b>	Aqueous/Soil					
<b>Analytical Group</b>	TPH-DRO (C9-C40)					
<b>Analytical Method/ SOP Reference</b>	SW-846 8015B/Lab SOP 3					
<b>QC Sample</b>	<b>Frequency/ Number</b>	<b>Method/SOP QC Acceptance Limits</b>	<b>Corrective Action</b>	<b>Person(s) Responsible for Corrective Action</b>	<b>DQI</b>	<b>MPC</b>
Surrogates	Two per sample.	%Rs must be within: Orthoterphenyl 50-150%.	Unless obvious chromatographic interference, if sample volume available, re-extract. Report both if second successful analysis is outside holding time or both fail QC criteria. Flag with * on Form 2.	Analyst, Supervisor	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
Temperature Blank	One per cooler.	<6° C.	Laboratory will notify Tetra Tech Project Chemist of temperatures outside criteria. Tetra Tech Project Chemist will respond as to whether to proceed with analysis.	Analyst, Supervisor	Accuracy/Bias/ Representative- ness	Same as Method/SOP QC Acceptance Limits.
Results between DL and LOQ	NA	Apply "J" qualifier to results between DL and LOQ.	NA	Analyst, Supervisor	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.

<b>Matrix</b>	Aqueous/Soil					
<b>Analytical Group</b>	Pesticides, PCBs					
<b>Analytical Method/ SOP Reference</b>	SW-846 8081B/8082A/Lab <a href="#">SOP 2, 14</a>					
<b>QC Sample</b>	<b>Frequency/ Number</b>	<b>Method/SOP QC Acceptance Limits</b>	<b>Corrective Action</b>	<b>Person(s) Responsible for Corrective Action</b>	<b>DQI</b>	<b>MPC</b>
Method Blank	One per preparation batch of 20 or fewer samples of similar matrix.	No target analytes > one half of LOQ.	First reanalyze, possibly re-extract batch, qualify data.	Analyst, Supervisor	Accuracy/Bias, Contamination	Same as Method/SOP QC Acceptance Limits.
MS	One per batch of 20 or fewer samples of similar matrix.	%R within DoD QSM limits.	Check LCS and instrument performance, qualify data.	Analyst, Supervisor	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
MSD	One per batch of 20 or fewer samples of similar matrix.	%R and RPD within DoD QSM limits.	Check LCS and instrument performance, qualify data.	Analyst, Supervisor	Accuracy/Bias and Precision	Same as Method/SOP QC Acceptance Limits.
LCS/LCSD	One per preparation batch of 20 or fewer samples of similar matrix. Include LCSD if preparation batch does not include MS/MSD.	%R and RPD within DoD QSM limits.	Check instrument performance, reanalyze, if recovery is high and sample is <LOQ narrate.	Analyst, Supervisor	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
Surrogates	Two per sample.	%Rs must be within: 8081 Pesticide: DCB 55-130% Soil, 30-135% Water, TCX 14-113% Soil, 25-140 Water. 8082 PCB: DCB 60-125% Soil, 40-135% Water, TCX 13-120% Soil, 34-137% Water.	Check instrument performance, reanalyze and qualify data.	Analyst, Supervisor	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.

<b>Matrix</b>	Aqueous/Soil					
<b>Analytical Group</b>	Pesticides, PCBs					
<b>Analytical Method/ SOP Reference</b>	SW-846 8081B/8082A/Lab <a href="#">SOP 2, 14</a>					
<b>QC Sample</b>	<b>Frequency/ Number</b>	<b>Method/SOP QC Acceptance Limits</b>	<b>Corrective Action</b>	<b>Person(s) Responsible for Corrective Action</b>	<b>DQI</b>	<b>MPC</b>
Temperature Blank	One per cooler.	<6° C.	Laboratory will notify Tetra Tech Project Chemist of temperatures outside criteria. Tetra Tech Project Chemist will respond as to whether to proceed with analysis.	Analyst, Supervisor	Accuracy/Bias/ Representative- ness	Same as Method/SOP QC Acceptance Limits.
Results between DL and LOQ	NA	Apply "J" qualifier to results between DL and LOQ.	NA	Analyst, Supervisor	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
Second Column Confirmation	All positive results must be confirmed.	Results between primary and second column must be RPD ≤ 40%. For Method 8082, report the greater of the two concentrations, unless there is interference.	None. Apply "J" flag if RPD >40% and discuss in the case narrative.	Analyst, Supervisor	Accuracy	Same as QC Acceptance Limits.

<b>Matrix</b>		Aqueous/Soil				
<b>Analytical Group</b>		Metals (ICP-AES)				
<b>Analytical Method/SOP Reference</b>		SW846 6010C/Lab SOP 5				
QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	MPC
Preparation Blank	One per preparation batch of 20 or fewer samples of similar matrix.	No target analytes > ½ LOQ.	Redigest and reanalyze, if sample concentration is >10X blank concentration narrate.	Analyst, Supervisor	Accuracy/Bias	Same as QC Acceptance Limits.
Interference Check Solutions (ICS-A and ICS-B)	At beginning and end of instrument run and after every 20 samples.	ICS-A: Unspiked analytes < LOD (unless they are a verified trace impurity from one of the spike analytes).  ICS-AB: %R must be within 80% - 120%.	Reanalyze samples analyzed after last acceptable ICS-A/ICS-B.	Analyst, Supervisor	Accuracy/Precision	Same as QC Acceptance Limits.
Serial Dilution	One per preparation batch of 20 or fewer samples of similar matrix.	%Difference must be between 90% - 110%.	Check instrument performance, qualify data.	Analyst, Supervisor	Accuracy/Bias, Precision	Same as QC Acceptance Limits.
LCS	One per preparation batch of 20 or fewer samples of similar matrix.	%R must be between 80% - 120%.	Redigest and reanalyze, if recovery is high and sample is <LOQ narrate.	Analyst, Supervisor	Accuracy/Bias	Same as QC Acceptance Limits.
Laboratory Duplicate	One per preparation batch of 20 or fewer samples of similar matrix.	RPD must be ≤20%	Check instrument performance, qualify data.	Analyst, Supervisor	Precision	Same as QC Acceptance Limits.
MS	One per preparation batch of 20 or fewer samples of similar matrix.	%R must be between 80% - 120%.	Perform post-digestion spike analysis, qualify data.	Analyst, Supervisor	Accuracy/Bias	Same as QC Acceptance Limits.

<b>Matrix</b>		Aqueous/Soil				
<b>Analytical Group</b>		Metals (ICP-AES)				
<b>Analytical Method/SOP Reference</b>		SW846 6010C/Lab <a href="#">SOP 5</a>				
QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	MPC
Post-Digestion Spike	For elements outside of QC limits in MS.	%R 75% - 125%	Check instrument performance, qualify data.	Analyst, Supervisor	Accuracy/Bias	Same as QC Acceptance Limits.
Temperature Blank	One per cooler.	<6° C	Laboratory will notify Tetra Tech Project Chemist of temperatures outside criteria. Tetra Tech Project Chemist will respond as to whether to proceed with analysis.	Analyst, Supervisor	Accuracy/Bias/ Representative- ness	Same as Method/SOP QC Acceptance Limits.

<b>Matrix</b>		Aqueous/Soil				
<b>Analytical Group</b>		Metals (ICP-MS)				
<b>Analytical Method/SOP Reference</b>		SW-846 6020/Lab <a href="#">SOP 13</a>				
QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	MPC
Preparation Blank	One per preparation batch of 20 or fewer samples of similar matrix.	No target analytes > one half of LOQ.	Redigest and reanalyze, if sample concentration is >10X blank concentration narrate.	Analyst, Supervisor	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
ICS-A and ICS-B	Beginning of each analytical run or every 12 hours, whichever is more frequent.	ICS-A: Unspiked analytes $\leq$ LOD, (unless they are a verified trace impurity from one of the spike analytes).  ICS-AB: Recovery of each analyte within $\pm$ 20% of true value.	Reanalyze samples analyzed after last acceptable ICS-A/ICS-B.	Analyst, Supervisor	Accuracy/ Precision	Same as Method/SOP QC Acceptance Limits.
Serial Dilution	One per preparation batch of 20 or fewer samples of similar matrix.	%Difference must be between 90% - 110% when sample concentration is >50X LOQ.	Check instrument performance, qualify data.	Analyst, Supervisor	Accuracy/Bias, Precision	Same as Method/SOP QC Acceptance Limits.
LCS	One per preparation batch of 20 or fewer samples of similar matrix.	%R must be between 80% - 120%.	Redigest and reanalyze, if recovery is high and sample is <LOQ, narrate.	Analyst, Supervisor	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
Laboratory Duplicate	One per preparation batch of 20 or fewer samples of similar matrix.	RPD must be $\leq$ 20%.	Check instrument performance, qualify data.	Analyst, Supervisor	Precision	Same as Method/SOP QC Acceptance Limits.

<b>Matrix</b>		Aqueous/Soil				
<b>Analytical Group</b>		Metals (ICP-MS)				
<b>Analytical Method/SOP Reference</b>		SW-846 6020/Lab <a href="#">SOP 13</a>				
QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	MPC
MS	One per preparation batch of 20 or fewer samples of similar matrix.	%R must be within 75% - 125%.	Perform post-digestion spike analysis, qualify data.	Analyst, Supervisor	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
Post-Digestion Spike	When MS fails.	%R must be 75% - 125%.	Check instrument performance, qualify data.	Analyst, Supervisor	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
IS	IS required for all analytes in all samples. IS must not interfere with target analytes.	For each sample, IS intensity within 30%-120% of that of initial calibration standard.  For initial calibration verification (ICV), initial calibration blank (ICB), CCV, and continuing calibration blank (CCB), IS intensity within 80%-120% of that initial calibration standard.	Verify that instrument is not drifting by evaluation of CCV and CCB. Dilute sample 5X and reanalyze, repeat.	Analyst, Supervisor	Accuracy/ Precision	Same as Method/SOP QC Acceptance Limits.
Temperature Blank	One per cooler.	<6° C.	Laboratory will notify Tetra Tech Project Chemist of temperatures outside criteria. Tetra Tech Project Chemist will respond as to whether to proceed with analysis.	Analyst, Supervisor	Accuracy/Bias/ Representative- ness	Same as Method/SOP QC Acceptance Limits.



<b>Matrix</b>		Aqueous/Soil				
<b>Analytical Group</b>		Metals (Mercury)				
<b>Analytical Method/SOP Reference</b>		SW-846 7471B/Lab <a href="#">SOP 6</a>				
<b>QC Sample:</b>	<b>Frequency/ Number</b>	<b>Method/SOP QC Acceptance Limits</b>	<b>Corrective Action</b>	<b>Person(s) Responsible for Corrective Action</b>	<b>DQI</b>	<b>MPC</b>
Preparation Blank	One per preparation batch of 20 or fewer samples of similar matrix.	Mercury < LOQ.	Redigest and reanalyze, if sample concentration is >10X blank concentration, narrate.	Analyst, Supervisor	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
LCS	One per preparation batch of 20 or fewer samples of similar matrix.	%R must be between 80% - 120%.	Redigest and reanalyze, if recovery is high and sample is <LOQ, narrate.	Analyst, Supervisor	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
Laboratory Duplicate	One per preparation batch of 20 or fewer samples of similar matrix.	RPD must be ≤20%.	Check instrument performance, qualify data.	Analyst, Supervisor	Precision	Same as Method/SOP QC Acceptance Limits.
MS	One per preparation batch of 20 or fewer samples of similar matrix.	%R must be between 75% - 125%.	Check instrument performance, qualify data.	Analyst, Supervisor	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
Temperature Blank	One per cooler.	<6° C.	Laboratory will notify Tetra Tech Project Chemist of temperatures outside criteria. Tetra Tech Project Chemist will respond as to whether to proceed with analysis.	Analyst, Supervisor	Accuracy/Bias/Representativeness	Same as Method/SOP QC Acceptance Limits.

## 12.0 – Data Verification and Validation (Steps I and IIa/IIb) Process Table

(UFP-QAPP Manual Section 5.2.1, UFP-QAPP Manual Section 5.2.2, Figure 37 UFP-QAPP Manual, Table 9 UFP-QAPP Manual – Worksheet #s 34, 35, 36)

Data Review Input	Description	Responsible for Verification (name, organization)	Internal/External
Chain-of-Custody Forms	The Tetra Tech FOL or designee will review and sign the chain-of-custody form to verify that all samples listed are included in the shipment to the laboratory and that the sample information is accurate. The forms will be signed by the sampler, and a copy will be retained for the project file, Tetra Tech PM, and Tetra Tech Data Validators. The Tetra Tech FOL or designee will review the chain-of-custody form to verify that all samples listed in the SAP have been collected. All deviations will be documented in the report.	Sampler and FOL, Tetra Tech	Internal
Chain-of-Custody Forms	1 - The Laboratory Sample Custodian will review the sample shipment for completeness and integrity and will sign accepting the shipment. 2- The Tetra Tech Data Validators will check that the chain-of-custody form was signed and dated by the Tetra Tech FOL or designee relinquishing the samples and also by the Laboratory Sample Custodian receiving the samples for analyses.	1 - Laboratory Sample Custodian, Spectrum 2 - Data Validators, Tetra Tech	External
Chain-of-Custody Forms and SAP	Ensure that the custody and integrity of the samples were maintained from collection to analysis and that the custody records are complete and any deviations are recorded. Review that the samples were shipped and stored at the required temperature and preservation conditions for chemically preserved samples. Ensure that the analyses were performed within the holding times listed in the SAP.	Data Validators, Tetra Tech	External

Data Review Input	Description	Responsible for Verification (name, organization)	Internal/External
Sample Log Sheets, Chain-of-Custody Forms, SAP, and Laboratory Sample Login Documentation	Verify that information recorded on the log sheets is accurate and complete. Verify that samples were correctly identified, that sampling location coordinates are accurate, and that documentation establishes an unbroken trail of documented chain of custody from sample collection to report generation. Verify that the correct sampling and analytical methods/SOPs were applied. Verify that the sampling plan was implemented and carried out as written and that any deviations are documented. Document any discrepancies in the final report.	PM, FOL, or designee, Tetra Tech	Internal
SAP, Analytical SOPs, and Analytical Data Packages	Ensure that all laboratory SOPs were followed. Verify that the correct analytical methods/SOPs were applied. Establish that all method QC samples were analyzed and in control as listed in the analytical SOPs. If method QA is not in control, the Laboratory QAM will contact the Tetra Tech PM verbally or via e-mail for guidance prior to report preparation.	Laboratory QAM, Spectrum	Internal
SAP/Chain-of-Custody Forms	Check that all field QC samples determined necessary were collected as required.	FOL or designee, Tetra Tech	Internal
Analytical Data Package	Verify all analytical data packages for completeness. The Laboratory QAM will sign the case narrative for each data package.	Laboratory QAM, Spectrum	Internal
Electronic Data Deliverables (EDDs)/ Analytical Data Packages	Check each EDD against the chain-of-custody form and hard-copy data package for accuracy and completeness. Compare laboratory analytical results to the electronic analytical results to verify accuracy. Evaluate sample results for laboratory contamination, and qualify false detections using the laboratory method/preparation blank summaries. Qualify analyte concentrations between the DL and LOQ as estimated. Remove extraneous laboratory qualifiers from the validation qualifier.	Data Validators, Tetra Tech	External

<b>Data Review Input</b>	<b>Description</b>	<b>Responsible for Verification (name, organization)</b>	<b>Internal/External</b>
Analytical Data Package	Verify each data package for completeness. Request missing information from the Laboratory PM.	Data Validators, Tetra Tech	External
SAP/Laboratory Data Packages/EDDs	Ensure that the laboratory QC samples were analyzed and that the MPCs listed in were met for all field samples and QC analyses. Check that specified field QC samples were collected and analyzed and that the analytical QC criteria set up for this project were met.	Data Validators, Tetra Tech	External
SAP/Laboratory Data Packages/EDDs	Check field sampling precision by calculating RPDs for field duplicate samples. Check laboratory precision by reviewing the RPD or percent difference values from laboratory duplicate analyses, MS/MSDs, and LCS/LCSD, if available. Ensure compliance with the methods and project MPCs accuracy goals listed in the SAP.	Data Validators, Tetra Tech	External
SAP/Laboratory Data Packages/EDDs	Check that the laboratory recorded the temperature at sample receipt and the pH of samples preserved with acid or base to ensure sample integrity from sample collection to analysis.	Data Validators, Tetra Tech	External
SAP/ Laboratory Data Packages/EDDs	Review the chain-of-custody forms generated in the field to ensure that the required analytical samples have been collected, appropriate sample identifications have been used, and correct analytical methods have been applied. The Tetra Tech Data Validator will verify that elements of the data package required for validation are present, and if not, the laboratory will be contacted and the missing information will be requested. Check that all data have been transferred correctly and completely to the Tetra Tech Structured Query Language (SQL) database.	Data Validators, Tetra Tech	External
SAP/ Laboratory Data Packages/ EDDs	Ensure that the project LOQs listed in SAP were achieved.	Data Validators, Tetra Tech	External

Data Review Input	Description	Responsible for Verification (name, organization)	Internal/External
SAP/Laboratory Data Packages/EDDs	Discuss the impact on DLs that are elevated because of matrix interferences. Be especially cognizant of and evaluate the impact of sample dilutions on low-concentration analytes when the dilution was performed because of the high concentration of one or more other contaminants. Document this usability issue and inform the Tetra Tech PM. Review and add PSLs to the laboratory EDDs. Flag samples and notify the Tetra Tech PM of samples with concentrations exceeding the PSLs listed in SAP.	Data Validators, Tetra Tech	External
SAP/Laboratory Data Packages/EDDs	Ensure that all QC samples specified in the SAP were collected and analyzed and that the associated results were within prescribed SAP acceptance limits. Ensure that QC samples and standards prescribed in analytical SOPs were analyzed and within the prescribed control limits. If any significant QC deviations occur, the Laboratory QAM shall have contacted the Tetra Tech PM.	Data Validators, Tetra Tech	External
SAP/Laboratory Data Packages/EDDs	Summarize deviations from methods, procedures, or contracts in the Data Validation Report. Determine the impact of any deviation from sampling or analytical methods and SOPs requirements and matrix interferences effect on the analytical results. Qualify data results based on method or QC deviation and explain all the data qualifications. Print a copy of qualified data stored in the project database to depict data qualifiers and data qualifier codes that summarize the reasons for data qualifications. Determine if the data met the MPCs and determine the impact of any deviations on the technical usability of the data.	Data Validators, Tetra Tech	External

## 12.1 VALIDATION SUMMARY

Analytical Group	Validation Criteria	Data Validator (title and organizational affiliation)
Soil and Aqueous VOCs, SVOCs (including low-level PAHs), Pesticides, PCBs, Metals, TPH- GRO (MTBE through Naphthalene) and TPH-DRO (C9-C40)	Validation of sample data will follow USEPA Region I guidelines for Tier II data review as outlined in the USEPA New England document titled "Environmental Data Review Supplement for Regional Data Review Elements and Superfund Specific Guidance/Procedures, April 2013" (USEPA, 2013). Tier II data validation will be performed for VOCs, SVOCs, pesticides, PCBs, metals, and TPH-DRO (C9-C40) and TPH-GRO (MTBE through naphthalene) by the analytical methods and criteria listed in this SAP and the current DoD QSM. A Tier II validation combines all elements included in a Tier I review, such as data completeness, data verification, and an evaluation of all method quality control parameters, plus a review of instrument raw data (chromatograms, quantitation results, mass spectra). One result per analytical fraction will be checked for calculation accuracy. USEPA National Functional Guidelines for Organic Data Validation (USEPA, 2008) and USEPA National Functional Guidelines for Inorganic Data Review (USEPA, 2010) will be used to apply qualifiers to data to the extent possible.	Data Validation Specialist, Tetra Tech

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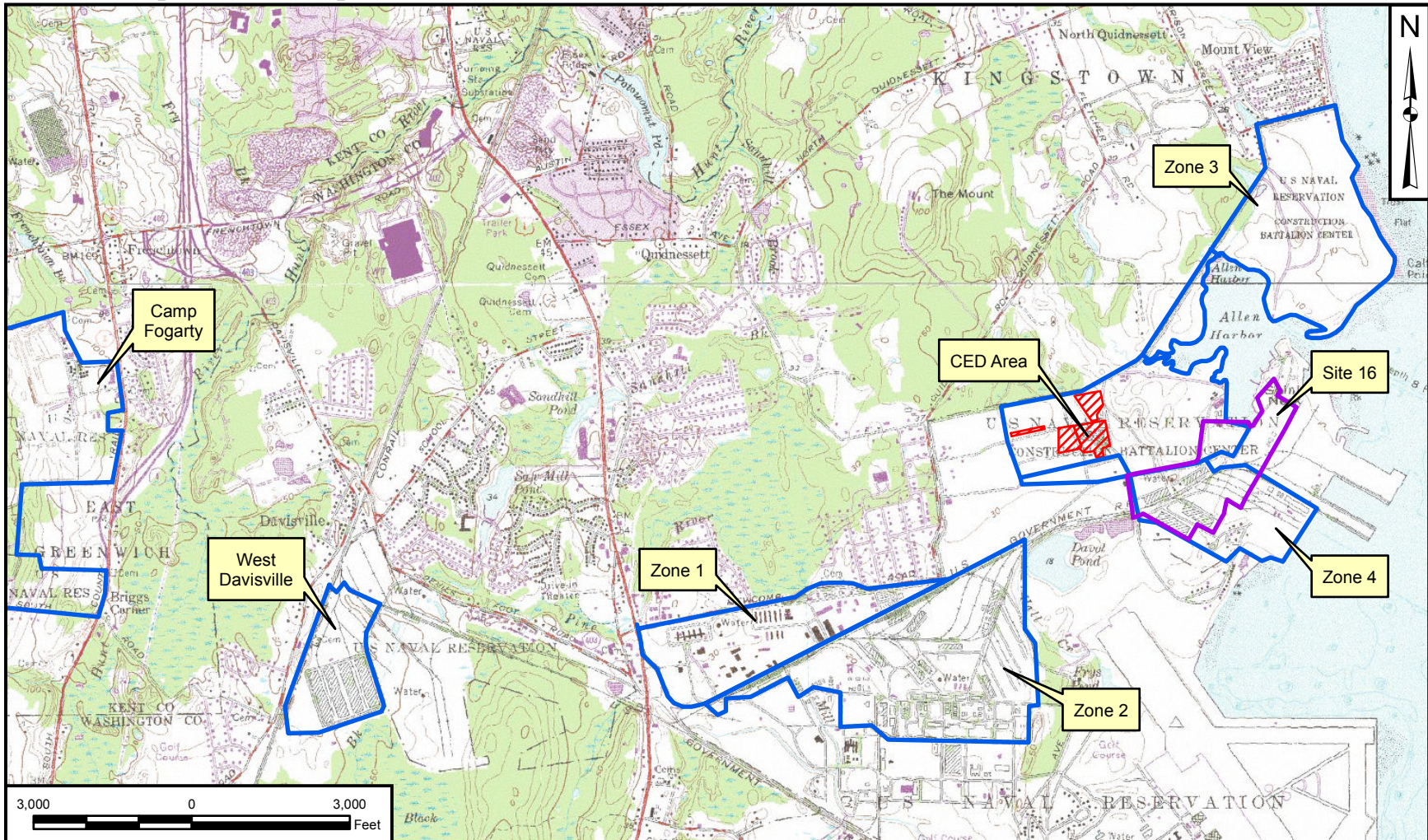
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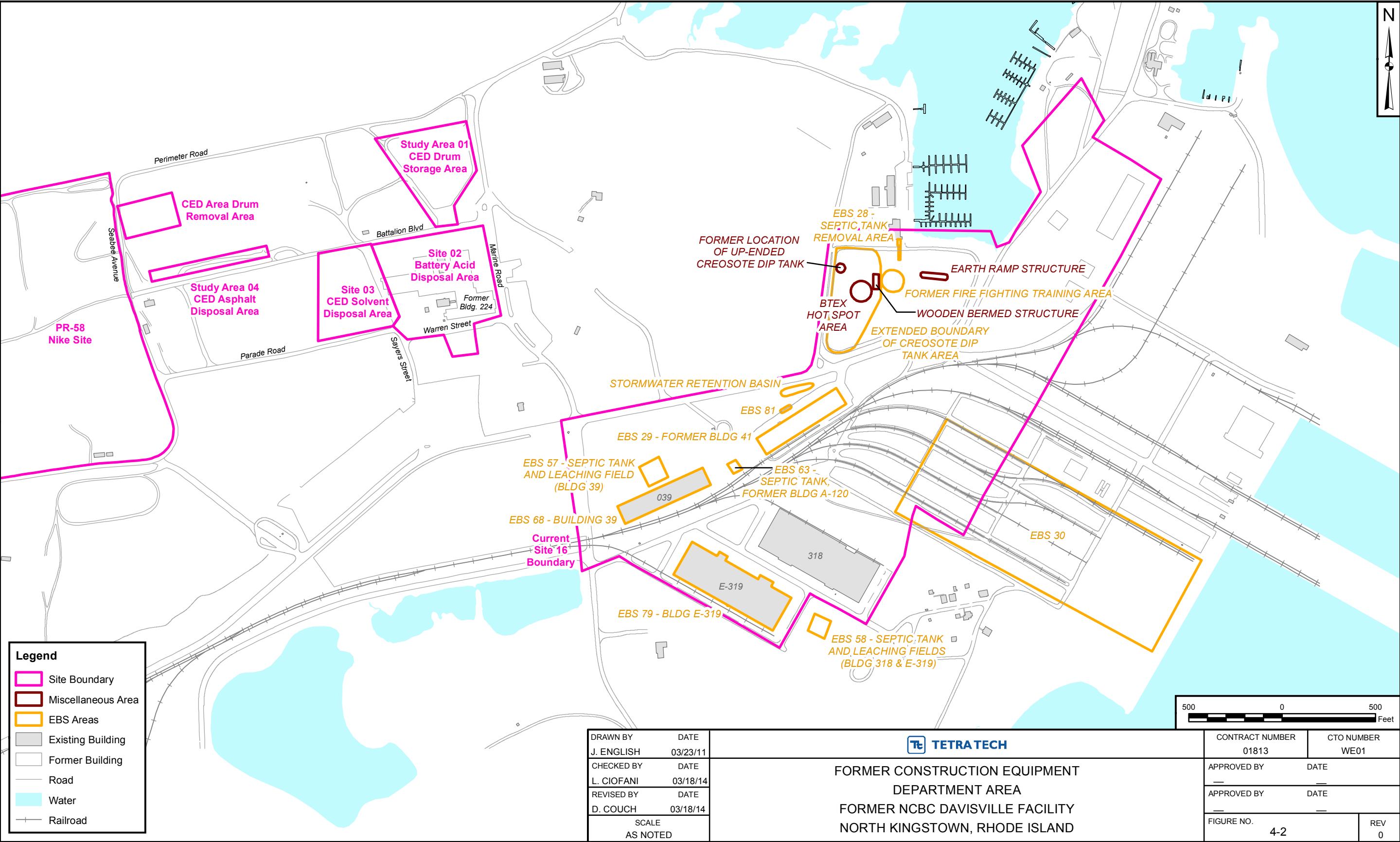


## FIGURES



DRAWN BY J. ENGLISH	DATE 03/23/11	<div> TETRA TECH</div> <div>SITE LOCATION MAP</div> <div>FORMER CONSTRUCTION EQUIPMENT DEPARTMENT (CED) AREA</div> <div>FORMER NCBC DAVISVILLE FACILITY</div> <div>NORTH KINGSTOWN, ROHODE ISLAND</div>	CONTRACT NUMBER 01813		
CHECKED BY L. CIOFANI	DATE 04/28/14		APPROVED BY —		DATE —
REVISED BY	DATE		APPROVED BY		DATE
SCALE AS NOTED			FIGURE NO.		REV 0









DRAWN BY J. NOVAK	DATE 03/05/13	<div>TETRA TECH</div> <div>HISTORICAL TPH CONCENTRATIONS AND PROPOSED SAMPLING LOCATIONS AT SITE 03</div> <div>FORMER CONSTRUCTION EQUIPMENT DEPARTMENT AREA</div> <div>FORMER NCBC DAVISVILLE</div> <div>NORTH KINGSTOWN, RHODE ISLAND</div>	CONTRACT NUMBER	CTO NUMBER
CHECKED BY L. CIOFANI	DATE 04/29/14		APPROVED BY	DATE
REVISED BY D. COUCH	DATE 04/29/14		APPROVED BY	DATE
SCALE AS NOTED			FIGURE NO. 4-3	REV 0







**CONSTRUCTION WORKER**

INGESTION OF, DERMAL CONTACT WITH, AND INHALATION OF VOLATILES/FUGITIVE DUST FROM SOIL; INGESTION OF, DERMAL CONTACT WITH, AND INHALATION OF VOLATILES FROM GROUNDWATER.



**INDUSTRIAL WORKER**

INGESTION OF, DERMAL CONTACT WITH, AND INHALATION VOLATILES/FUGITIVE DUST FROM OF SOIL; INGESTION OF GROUNDWATER VAPORS (INDOOR AIR).

UPGRADIENT AREA:  
PR-58 NIKE SITE,  
SOURCE OF CVOC PLUME

STUDY AREA 04

CED AREA DRUM REMOVAL AREA

EASTERN ARM OF CVOC PLUME  
(DEEP OVERBURDEN & BEDROCK)

BURIED DEBRIS SPILLS/DISCHARGES  
(VARIOUS LOCATIONS THROUGHOUT SITES 1-4, CED AREA)  
GROUNDWATER FLOWS  
TO EAST/SOUTHEAST  
DISSOLVED PLUME



**RECREATIONAL USER**

INGESTION OF, DERMAL CONTACT WITH, AND INHALATION OF VOLATILES/FUGITIVE DUST FROM SOIL.



**HYPOTHETICAL FUTURE RESIDENT**

INGESTION OF, DERMAL CONTACT WITH, AND INHALATION OF VOLATILES/FUGITIVE DUST FROM SOIL; INGESTION OF, DERMAL CONTACT WITH, AND INHALATION OF VOLATILES FROM GROUNDWATER (SHOWERING/BATHING); INHALATION OF GROUNDWATER VAPORS (INDOOR AIR).

STUDY AREA 01

SITE 02



**ECOLOGICAL RECEPTORS  
(e.g. PLANTS, SMALL MAMMALS,  
AND BIRDS)**

DIRECT CONTACT WITH SURFACE SOIL AND INGESTION OF CONTAMINATED FOOD ITEMS.

**LEGEND:**



POTENTIAL LEACHING TO GROUNDWATER



POTENTIAL VAPOR INTRUSION



SITE BOUNDARY



WATER TABLE (APPROXIMATELY 10 FT. BGS.)

DRAWN BY	DATE
NN	2/24/14
CHECKED BY	DATE
REVISED BY	DATE
SCALE	
NOT TO SCALE	



CONCEPTUAL SITE MODEL  
FORMER CONSTRUCTION EQUIPMENT  
DEPARTMENT AREA  
FORMER NCBC DAVISVILLE FACILITY  
NORTH KINGSTOWN, RHODE ISLAND

CONTRACT NO. 1813	
OWNER NO.	
APPROVED BY	DATE
DRAWING NO. FIGURE 4-5	SIZE REV. B 0

## **APPENDIX A**

### **BCT TELECONFERENCE NOTES - DECEMBER 12, 2013**



## NOTES FOR THE 12 DECEMBER 2013 BCT TELECONFERENCE FORMER NCBC DAVISVILLE

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### ATTENDEES

David Barney (Navy)	Christine Williams (EPA)
Jeff Dale (Navy)	Richard Gottlieb (RIDEM)
William Brandon (EPA)	Andrew Glucksman (Mabbett)
Robert Shoemaker (Resolution)	Derek Pinkham (Tetra Tech EC)
Lee Ann Sinagoga (Tetra Tech)	Joe Logan (Tetra Tech)
Joe Foran (The Management Edge)	

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The 12 December 2013 Davisville BRAC Cleanup Team (BCT) teleconference began at 10:00 AM and concluded at approximately noon. The agenda for the teleconference is included as **Attachment A** of these notes.

Action Items are presented in **Attachment B**.

### AGENDA ITEM NO. 1: REVIEW OF OUTSTANDING ACTION ITEMS

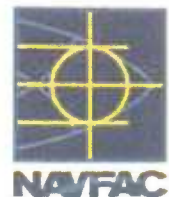
Outstanding action items from August 13, 2013, September 5, 2013, and November 12, 2013 BCT teleconferences were reviewed and updated as shown in **Attachment B**.

### AGENDA ITEM NO. 2: SITE 09 ANNUAL REPORT STATUS

The publication of the *Long-Term Monitoring Data Summary and Optimization Recommendations Report for Site 09* for sampling events conducted in 2011 and 2012 will be published in December 2013. The Navy will provide a briefing regarding this report to the team on January 15, 2014, 1:00 PM to 3:00 PM.

**Post Teleconference Note:** The referenced report was published on December 20, 2013.





### AGENDA ITEM NO 3: SITE 16 STATUS

The public comment period for Proposed Plan (PP) for Site 16 closed on November 14, 2013. No formal written or verbal comments were received. The responsiveness summary (in the Record of Decision [ROD]) will be completed accordingly. The ROD document is currently being reviewed by Navy-Legal. The target date for publication is December 30, 2013. R. Gottlieb requested two hard copies and one electronic copy (PDF). C. Williams requested three hard copies, one electronic copy (PDF), and one electronic copy (WORD version of text). **Post Teleconference Note:** The revised delivery date for the referenced report is January 17, 2014.

### AGENDA ITEM NO. 4: QDC-1 WETLAND STATUS

The following items summarize the major discussion points regarding this agenda item:

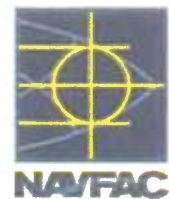
- The cold weather has impacted the progress of the pipeline cleaning because the water jet does not function properly when temperatures dip below 27 degrees F. It is anticipated that the subcontractor will complete the task within a week pending weather conditions.
- The Coastal Zone Management (CZM) consistency determination was submitted and approved.
- Navy is currently reviewing EPA's comments on the remedial investigation (RI) work plan. C. Williams requested that Navy respond to comments by December 30, 2013, because the outfall 001 RI WP is a primary document for OU10 under the FFA and Navy has an obligation to respond to agency comments within 45 days.
- Most of the RI field work is planned for late January/February 2014 when the wetland is frozen. Surface water will be sampled in the March/April 2013 timeframe. Navy (J. Dale) will provide weekly updates during the field event.



## AGENDA ITEM NO. 5: PATH FORWARD FOR CED AREA

The following items summarize the major discussion points/agreements/issues regarding this agenda item:

- L. Sinagoga stated that the final version of the November 2012 risk evaluation of the CED Area soils (i.e., Study Areas 1 and 4, and Sites 02/03) has not been published because team consensus on the path forward for the CED area sites has not been reached. Specifically, the Navy has concluded that there is no unacceptable CERLCA risk at Study Area 01 and Sites 02/03. While the Navy is recommending that the Study Area 04 soils be addressed in a focused feasibility study (because of unacceptable CERCLA risk at this site) and that further investigation of the TPH soils contamination at Site 03 be conducted, no further action is recommended based on exceedances of RIDEM regulatory benchmarks at Study Area 01 or Sites 02/03 (i.e., exceedances for non-TPH parameters). RIDEM is not in agreement regarding the path forward for Sites 02/03 and is also recommending additional lead sampling at Study Area 04. R. Gottlieb's concerns were summarized in the November 12, 2013 teleconference notes.
- The team agreed to elevate this issue (informally) to Tier 2. Within the next 10 days, J. Dale will draft a concise "problem statement" stating the issue to be resolved. The statement will be forwarded to C. Williams and R. Gottlieb for review and then submitted to Tier 2. Statements can also be formulated independently by the Navy, EPA, and RIDEM in support of each Agency's position and forwarded to Tier 2. **Post Teleconference Note:** The team (C. Williams, R. Gottlieb, and J. Dale) elected to continue discussion at the Tier 1 level in lieu of elevating to Tier 2.
- The team continues to agree that NFA is necessary for Study Area 01 soils and that the Study Area No. 4 soils contamination be addressed in a focused feasibility study.
- R. Gottlieb reiterated the RIDEM position that the soils demonstrating exceedances of RIDEM regulatory benchmarks cannot be moved off-site (i.e., deed restrictions should prohibit such actions).

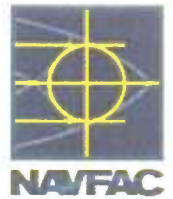


- Navy presented its current sampling proposal for the CED area. It includes (see Attachment C):
  - Further evaluation (sampling) of residual TPH contamination at Site 03. Based on the TPH soil sampling grid presented, R. Gottlieb recommended an additional 6 to 8 grid points at the edges of the currently recommended sampling locations to assure that the TPH contamination was bounded vertically and horizontally. J. Dale agreed.
  - Sampling of select shallow zone wells to confirm that chemical migration from soils to groundwater (i.e., the leachability concern) is not an issue and to further evaluate the vapor intrusion pathway. The proposed analytical program for all of the shallow wells would be VOCs, TPH, naphthalene, and unfiltered/filtered metals. C. Williams stated that recommended resampling of MW-1-10S, -13S, and -14S (see recommendations table in Attachment C) may indeed provide useful perspective; however, these wells may or may not be suitable background wells. The Navy is currently considering the use of these wells as CED-specific background wells.

The EPA/RIDEM will review the sampling recommendations provided in the Attachment C tables and figures and provide our first impressions by January 15, 2014. The Navy will then prepare a streamlined SAP prior to conducting the work for regulatory review and approval.

The following CED area items were also briefly discussed:

- J. Dale provided some preliminary soil data for samples from the drum excavation area in the northwest corner of the general CED area. TPH data will also be distributed in the near future; all TPH results appear to be less than 500 mg/kg. Navy will conduct a risk evaluation based on the data for the removal action soils. The analysis may or may not be an addendum to the current risk evaluation of the CED area soils. **Post Teleconference Note:** TPH results were provided to the agencies in January 2014. The Navy also included the entire data set with risk numbers for comparison.



- J. Dale/C. Williams briefly discussed whether or not the drum removal area should be considered a separate site or a component of the CED area. Note that the CED area and all associated investigations are often referred to as Site 03 in some of the Navy's documentation. This issue was not resolved. C. Williams still recommends that the Navy pursue an interim action memorandum for the groundwater and then a final groundwater ROD once decisions regarding the NIKE site have been made by the USACE.
- D. Barney stated Navy plans to distribute the Action Memo for the drum removal action to the public within the next few weeks.
- S. Anderson/J. Dale will send SOPs for well installation, well sampling, and Color Tec sampling/analysis to EPA/RIDEM/D. Pinkham. C. Williams indicated that EPA needs copies of these documents for the Agency's files. The Agency may or may not be submitting comments on these SOPs. J. Dale noted that the Navy provided the decision logic for installation of the new drum removal action wells (and associated screen interval depths) during the November 12 BCT teleconference.

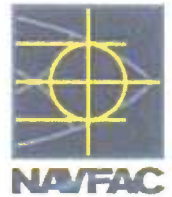
The next BCT teleconference is scheduled for Wednesday, January 15, 2014, 1:00 to 3:00 PM. As noted above, the Navy will provide a briefing on the Site 09 annual report published on December 20, 2013.

New action items, developed during the December 12, 2013 BCT teleconference, are provided in **Attachment B**.

**ATTACHMENT A**

**AGENDA**





**AGENDA**  
**FORMER NCBC DAVISVILLE**  
**BRAC Cleanup Team (BCT Teleconference)**

Call in # 1-866-692-5721

Participant Code: 9158476

**Date: December 12, 2013**

**Time: 10:00 AM to Noon**

**Discussion Lead: Jeff Dale**

**AGENDA**

**1) Introduction**

**Goals:**

- a. Review outstanding Action Items from November 12<sup>th</sup> BCT notes

**2) Site 09 Annual Report Status**

**Goals:**

- a. Update team - Report to be published mid-December 2013.
- b. Schedule team call for summary/presentation of conclusions in the report.

**3) Site 16 Status**

**Goal: Update Team.**

- a. Public comment period closed November 14. No formal comments received.
- b. Internal Draft ROD currently being reviewed by Navy legal.
- c. Draft ROD & responsiveness summary due to EPA/RIDEM on December 30<sup>th</sup>.

**4) QDC-1 Wetland Status:**

**Goal: Update Team.**

- a. Pipeline cleaning completed.
- b. Navy currently preparing responses to EPA comments on RI Workplan.
- c. CZM consistency determination.



#### **5) Path Forward for CED Area**

##### **Goals:**

- a. Update team – Draft Final Human Health Risk Assessment (SA1&4 Sites 2&3) to be published week of Dec 9<sup>th</sup>, 2013
- b. Present sampling ideas to resolve soil/groundwater data gaps for FFS/early action (other than drum burial data)
  - 1. TPH in soil at site 3
  - 2. Leachability concerns

#### **6) Wrap Up**

##### **Goals:**

- a. Agree on action items from this call
- b. Confirm date and agenda of next call (before January 15)

Supporting information will be provided via adobe connect NCBC Davisville site.

<https://epa.connectsolutions.com/davisville/>

**Action Items from Nov 12<sup>th</sup>, 2013 BCT Teleconference**

**See separate file**

**ATTACHMENT B**

**ACTION ITEM LIST**





## UPDATED ACTION ITEMS FROM THE 12<sup>th</sup> DECEMBER 2013 BCT TELECONFERENCE FORMER NCBC DAVISVILLE

### NEXT TELECONFERENCE:

The next BCT teleconference is set for Wednesday, January 15<sup>th</sup>, 2013, 1 PM to 4 PM.

### Action Items:

Status of August 13, 2013 Items (Pending items are highlighted in yellow; all other Aug 13<sup>th</sup> items completed):

Status	Date Completed	Item
Done	8/19/13	1) Send CED Area Geophysical Report to BCT. (ASAP) (J Dale).
Done	8/14/13	2) Send June 11, 2013 BCT teleconference notes to BCT. (ASAP) (J Dale).
Done	8/26/13	3a) Send RTCs for regulatory comments received on work plans for QDC outfall RI.
Done	9/18/13	3b) Provide schedule for RTC for QDC-1 pipe cleaning (Aug 26th) (J Dale/R Shoemaker).
Revised target submission date for main report is 12/20/13.		4) Send schedule for submittal of Site 09 Annual Report (including shellfish consumption human health risk assessment) (J Dale/S Anderson). (Item revised 12_13_13)
Done	8/20/13	5) Send RTCs for EPA June proposal regarding the synoptic GW events for Site 07. Include proposal for decrease in well numbers to counter-balance need for synoptic event.
Done.	9/05/13	6) Send missing table from Feb 19 E-mail that further identified EPA recommendations regarding LTM sampling at Site 09. (ASAP) (Christine Williams). NOTE: This was an internal table and will not be distributed.
Done	9/05/13	7) Review and prepare response to EPA Feb 19th E-mail (including response to items on missing table for Site 09). Monitoring at Location 10S? Monitoring at piezometer location 05 (including co-located sediments)? Analytical program for co-located SD/shellfish/piezometer?(Aug 20th in prep for Sept 5 teleconference) (J Dale/S Anderson).



Done	8/13/13	8) Complete internal ARAR discussions for Site 16 based on July 31, teleconference. (Aug 14)(D Barney/E Balsamo).
Done	8/20/13	9) Add summary bullets from July 9, 2013 teleconference to BCT teleconference notes of Aug 13. (Aug 20) (LA Sinagoga).
Done	9/11/13	10) Send CED area drum removal work plan to BCT. (J Dale)
Done	8/22/13	11) Send follow-up RTCs and DF version of PP/FSA for Site 16. (Sept 6th or 13th.) (LA Sinagoga)
Done	8/15/13	12) Check out Pb units for CED Study Area 04 (LA Sinagoga).
Done	8/15/13	13) Send Excel tables of CED area data to Rich Gottlieb (LA Sinagoga).
Done	8/22/13	14) Send Dave Peterson's ARARs tables for the Site 07 ESD. (Aug 19) (C Williams)
Revised target date for completion report letter was not specified.		15) Send RTCs on EPA ESD comments. ESD comments currently being reviewed by Navy counsel. (Item revised 11_12_13) (J Dale/R Shoemaker). As of 12_12_13, Navy indicates that it may be <b>retracting ESD</b> , the action is a "self-contained event"; it did not affect the ROD. Recommendation: <b>C. Williams</b> will check e-mail files on <b>12_16_13</b> to see if EPA can concur that the action has been completed and will advise team. Navy may need to <b>send follow-up retraction letter to close the file/loop.</b>
Done	8/19/13	16) Send RTCs on EPA comments on geophysics work plan for CED area. (Sept 13 email) (J Dale)

**Status of September 5, 2013 Items (Pending items are highlighted in yellow; all other Sept 5<sup>th</sup> items completed):**

Status	Date Completed	Item
Done		1) Navy (LA Sinagoga) will finalize BCT teleconference notes of 6.11.13, 7.31.13, and 8.13.13 with consideration of the RIDEM comments received in E-mails of 8.14.13 and 8.21.13. (Target date = 9.13.13.)
Done	9/18/13	2) Navy (J Dale and S Anderson) will update and forward Site 07 LTM table and "level of interpretation" agreements per BCT discussions of 9.5.13. (Target date = 9.10.13.)
Done	9/18/13	3) Navy (J Dale and S Anderson) will update and forward Site 09 LTM table and "level of interpretation" agreements per BCT discussions of 9.5.13. (Target date = not specified??)
Revised target date =		4) EPA (W. Brandon) will make recommendation regarding when to collect synoptic water level measurements



Jan/Feb 2014 timeframe.		(incoming or outgoing tide? Low, mid, or high tide?). (Item revised 11_12_13). As of 12_12_13, <b>Jeff Dale</b> will schedule a call with Scott Anderson and Bill Brandon in Jan/Feb 2014 to come to conclusion on this item.
Completed		5) Navy (R. Shoemaker) will conduct Fall LTM for Sites 07 and 09. (Target date = Sept/Oct timeframe.)
Completed		6) Navy (Dave Barney) will confirm Site 16 Public Hearing date of 10.24.13 and associated logistics. (Target date = not specified.)
Completed	9/18/13	7) Navy (LA Sinagoga and J Logan) will publish <b>Final?</b> FSA and PP documents for Site 16. (Target date = not specified, pending OK from Navy legal?)
Done	9/19/13	8) Navy will cancel Sept RAB..... to be reschedule in Oct. (Target date = not specified.)
Done	9/16/13	9) Navy (R. Shoemaker) to verify that the Site 09 flush mount wells are accessible. (Target date = not specified.)

**Status of November 12<sup>th</sup>, 2013 BCT Call Action Items (Pending items are highlighted in yellow; all other Nov 12<sup>th</sup> items completed):**

Status	Date Completed	Item
Target Date not specified.		1) Advise Jeff Dale regarding any EPA concerns/comments regarding QDC RI Work Plan. (C Williams). C Williams provided letter on 11/14/13; and Navy is responding to EPA and RIDEM follow-up comments.
As is necessary.		2) Share weekly updates regarding field work accomplished at CED area sites and QDC Wetland. (J Dale)
Target Date: Mid December	12_12_13. Overview of sampling program presented/discussed during BCT teleconference.	3) Prepare/submit sampling proposal for CED (Sites 1 through 4). (J Dale/ Tt)





## New Action Items Developed During December 12<sup>th</sup>, 2013 BCT Call:

Status	Date Completed	Item
Target Date = 12_30_13.		1) Wetland OU 10 WP responses due to regulators. (J Dale and R Shoemaker)
Target Date = 12_20_13?		2) CED area soil problem statement drafted for EPA/RIDEM review before sending to Tier 2 (J Dale)
Target Date not specified.		3) Re-submit Navy SOPs for soil coring and well installation to EPA and RIDEM. (J Dale)
Target Date: Jan 15, 2014		4) EPA/RIDEM to send thoughts on preliminary CED area sampling proposal (C Williams, R Gottlieb)
Within the next 2 weeks		5) Action memo for CED area drum removal action for public review (J Dale/D Barney).
Target Date: Dec 30, 2013		6) Site 16 ROD to EPA (3 hard copies and one electronic copy; PDF and WORD versions) and RIDEM (2 hard copies.) (L Sinagoga)
Target Date: Jan 15, 2014		7) Presentation (via teleconference) of Site 09 LTM report to be distributed week of 12/16/13. (S Anderson; L Sinagoga)

## **ATTACHMENT C**

### **DRAFT CED AREA SAMPLING IDEAS**

**TABLE**  
**WELLS RECOMMENDED FOR ADDITIONAL SAMPLING**  
**FORMER CONSTRUCTION EQUIPMENT DEPARTMENT (CED)**  
**FORMER NCBC DAVISVILLE FACILITY**  
**NORTH KINGSTOWN, RHODE ISLAND**

Well Location Identifier	Primary Rationale for Sampling (1)
<b>MW01-10S, MW01-13S and/or MW01-14S</b>	Based on historical data, very low level VOCs only and low metals concentrations only. Candidate wells for <b>CED-area-specific</b> background metals?
<b>25MW-01S</b>	VOC contamination previously detected.
<b>MW02-04S</b>	Recommended primarily for naphthalene sampling. Naphthalene was detected in sample 02-B15-04-6-8 in Site 02 subsurface soil. This well is likely downgradient of location 02-B15-04-6-8. MTBE detected in 2007 samples.
<b>MW02-05S</b>	Recommended primarily for metals sampling. MW02-05S is likely downgradient from metals concentrations in Site 02 surface soil exceeding refined groundwater protection criteria and facility background concentrations (e.g., 02-B17-01). MTBE detected in 2007 sample.
<b>MW02-06S</b>	Recommended primarily for metals sampling. MW02-06S is likely downgradient from metals concentrations exceeding refined groundwater protection criteria (e.g., 02-B15-01).
<b>MW02-08S</b>	Recommended primarily for metals sampling. MW02-08S is likely downgradient from elevated concentrations of some metals concentrations in Site 02 subsurface soil (detected at B-02-08-04-S and B-02-10-08-S) and the maximum concentration of some metals in Site 02 subsurface soil (detected at B-02-10-04-S). Some metals concentrations in Site 02 subsurface soil exceeded refined groundwater protection criteria and facility background concentrations.
<b>MW02-09S</b>	Recommended primarily for metals sampling. MW02-09S is likely downgradient from the maximum metals concentration in Site 02 surface soil (detected at 02-B17-01). Metals concentrations in Site 02 surface soil exceeded refined groundwater protection criteria and facility background concentrations.
<b>MW02-10S</b>	Recommended primarily for naphthalene sampling. Naphthalene was detected in sample 02-B15-04-6-8 in Site 02 subsurface soil. This well is downgradient of location 02-B15-04-6-8. VOC contamination detected in 2007 samples.

**TABLE**  
**WELLS RECOMMENDED FOR ADDITIONAL SAMPLING**  
**FORMER CONSTRUCTION EQUIPMENT DEPARTMENT (CED)**  
**FORMER NCBC DAVISVILLE FACILITY**  
**NORTH KINGSTOWN, RHODE ISLAND**

<b>MW03-01S</b>	Recommended primarily for metals sampling. MW03-05S is downgradient from the maximum concentrations of some metals in Site 03 surface soil (detected at S-03-03-00-S and B-03-02-06-S, respectively) . Some metals concentrations in Site 03 surface soil exceeded refined groundwater protection criteria and facility background concentrations.
<b>MW03-02S</b>	Recommended primarily for metals sampling. MW03-02S is co-located with the maximum detections of some metals in Site 03 subsurface soil. Some metals concentrations in Site 03 subsurface soil exceeded refined groundwater protection criteria and facility background concentrations.
<b>MW03-04S</b>	Recommended primarily for TPH sampling. TPH concentrations exceeding groundwater protection criteria were scattered across Site 03 (i.e., locations SS3C-1 and S-03-01-00-S through S-03-10-00-S). This well is likely downgradient of Site 03. Available shallow groundwater samples do not include TPH results.
<b>MW03-05S</b>	Recommended primarily for TPH sampling. TPH concentrations exceeding groundwater protection criteria are scattered across Site 03 (i.e., locations SS3C-1 and S-03-01-00-S through S-03-10-00-S). MW03-05S is likely downgradient of Site 03. Available shallow groundwater samples do not include TPH results.
<b>All New Drum Area wells</b>	Recommended in support of drum removal investigation to the northwest of existing CED area sites.
<b>1) New drum area wells to be sampled for TAL metals (total and dissolved) and TCL VOCs, SVOCs, PP, and extractable TPH (C9-C-40). Existing wells to be sampled for TCL VOCs, naphthalene, TAL metals (total and dissolved), and extractable TPH (C9-C-40).</b>	

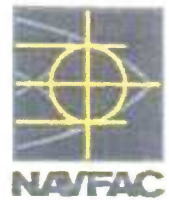






## **APPENDIX B**

**BCT TELECONFERENCE NOTES - NOVEMBER 12, 2013**



## NOTES FOR THE NOVEMBER 12<sup>TH</sup> 2013 BCT TELECONFERENCE FORMER NCBC DAVISVILLE

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### ATTENDEES

David Barney (Navy)	Christine Williams (EPA)
Jeff Dale (Navy)	Richard Gottlieb (RIDEM)
William Brandon (EPA)	Andrew Glucksman (Mabbett)
Robert Shoemaker (Resolution)	Rachel MacPhee (Resolution)
Lee Ann Sinagoga (Tetra Tech)	Joe Logan (Tetra Tech)
Patty Dunn (The Management Edge)	Scott Anderson (Tetra Tech)
Derek Pinkham (Tetra Tech)	

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The 12<sup>th</sup> November 2013 Davisville BRAC Cleanup Team (BCT) teleconference began at 10:00 AM and concluded at approximately noon. The agenda for the teleconference is included as **Attachment A** of these notes.

*Action Items are presented in Attachment B.*

### AGENDA ITEM NO. 1: REVIEW OF OUTSTANDING ACTION ITEMS

Outstanding action items from August 13<sup>th</sup>, 2013 and September 5<sup>th</sup>, 2013 BCT teleconferences were reviewed and updated as shown in **Attachment B**.

### AGENDA ITEM NO. 2: CED AREA DRUM REMOVAL STATUS

J. Dale and D. Pinkham updated the BCT regarding the removal action:

- Twelve drums were suspected; nine drums were removed; materials were only found in the drum originally unearthed by QDC.
- Soil samples were collected from beneath the drums and a pipe identified by the geophysical survey (4-5' bgs) during the excavation. Additional soil samples were collected where drums were not buried to obtain a larger data set. No staining was observed.





- Analytical results will be forwarded once all data has been received and sampling location figures prepared.
- Soil piles and metals debris will be removed. Vendors have been selected for disposal.

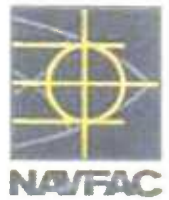
EPA expressed concerns that not all anomalies identified via the geophysical surveys were resolved and that ponding in some portions of the site limited some of the surveys performed. S. Anderson indicated that there was a certain level of redundancy regarding the surveys conducted somewhat compensating for that fact that ground penetrating radar (GPR) could not be conducted at all planned locations (e.g., an EM survey was performed at these locations.) J. Dale stated that the area will be resurveyed once the excavation has been completed. Additional excavations would only be conducted if those surveys identified "drum signatures".

The BCT discussed and agreed upon the three locations of new well clusters to be installed in the CED drum removal area (see figure in **Attachment C**). Continuous coring and CVOC screening (via Color Tec technology) will be conducted at each well cluster to profile the soil at the first and deepest well.

- The first boring will be completed to a fine sand unit expected to be above the silt unit (approximately 45 feet below ground surface). This sand unit is identified as LS1 in the 2011 Army RI for the NIKE PR 58 Site. The well screen for the first well will be set at the base of the LS1;
- The second well screen will be set at the water table; and
- If a second distinct sand unit is identified above the LS1 and greater than eight feet below the water table, a third well screen would be set in this second sand unit. This sand unit is identified as LS2 in the 2011 Army RI for the NIKE PR 58 Site.

#### **AGENDA ITEM NO. 4: SITE 16 STATUS**

Navy (J. Dale and D. Barney) indicated that no formal written or verbal comments have been received to date on the Proposed Plan (PP) for Site 16. The public comment period for the PP ends November 14<sup>th</sup>, 2013. The draft ROD is currently being reviewed by the Navy. It is due to EPA/RIDEM 45 days after the public comment period (December 30<sup>th</sup>, 2013). EPA requested that it be submitted earlier if possible. Ideally, the ROD will be finalized in the first calendar quarter of 2014 (i.e., by March 31, 2013).



**Post Teleconference Note:** The public comment period closed on November 14<sup>th</sup>, 2013. No formal written or verbal comments were received on the PP for Site 16. The responsiveness summary will be completed accordingly.

#### **AGENDA ITEM NO. 5: QDC-1 WETLAND STATUS**

The following items summarize the major discussion points/agreements regarding this agenda item:

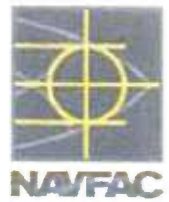
- The QDC raised the one manhole necessary to perform the proposed pipe cleaning which is planned for late November or early December 2013. The contract for the pipe cleaning is in-place (Cyn Environmental). The Coastal Zone Management (CZM) consistency determination will be submitted prior to the work. The QDC has requested that the Navy keep the drain line functional post cleaning.
- EPA (C. Williams) to advise Navy if there are any concerns regarding Navy's response to EPA's comments on the remedial investigation (RI) work plan.
- Most of the RI field work is planned for late January/February 2014 when the wetland is frozen. Surface water will be sampled in the March/April 2013 timeframe. Navy (J. Dale) will provide weekly updates during the field event.

#### **AGENDA ITEM NO. 3: PATH FORWARD FOR CED AREA**

**Note to reader:** To facilitate discussions on the other agenda items, the BCT decided to move this agenda item to the end of the teleconference.

The following items summarize the major discussion points/agreements/issues regarding this agenda item:

- L. Sinagoga acknowledged the RIDEM review of the CED Area summary table previously sent to the team (see **Attachment D**). The table compares the analytical results for the CED area sites to the requirements established in Section 8.10 of the RIDEM remediation regulations. The prompt review of the table was appreciated and is presented in an e-mail from RIDEM also included in **Attachment D**. The table will be referred to as the Section 8.10 Compliance Table in the following narrative. (It should be noted that RIDEM Section 8.10 is actually intended for the evaluation of post-remediation samples. At the suggestion of RIDEM, the Navy has evaluated



the existing CED area data against the RIDEM requirements contained therein in an effort to support risk management decision making for the CED area sites.)

- L. Sinagoga summarized that the Section 8.10 Compliance Table indicates that the analytical results for Study Area 01 (SA 01) meet the criteria established in RIDEM Section 8.10. The results for Sites 02 and 03 and Study Area 04 (SA 04) do not. However, she recommended that the results of the risk assessments presented in Revision 1 of the Human Health Risk Evaluation for the CED Area (November 2012) be considered in any risk management decision making because the observed exceedances of the DEC's are frequently marginal or sporadic in nature only. They are not indicative of wide-spread residual contamination. She explained that, for example, while some lead concentrations for some individual samples in SA01, Sites 02 and 03, and SA04 exceed RIDEM DEC's for the residential or industrial land use scenario, the results of the human health risk assessment indicated that, from a CERCLA risk assessment perspective, there no "unacceptable" risks due to lead exposures. This is because the EPA models used to evaluate exposures to lead generally recommend the use of the *arithmetic mean* lead concentration as the exposure point concentration. Arithmetic mean lead concentrations detected in the four CED area sites/study areas do not exceed EPA or RIDEM benchmarks.

Based on the November 2012 risk evaluation, the Navy recommends:

- Further evaluation (sampling) of residual TPH contamination at Site 03. *The team agreed with this recommendation.*
- Sampling of select shallow zone wells to confirm that chemical migration from soils to groundwater (i.e., the leachability concern) is not an issue. *The team agreed with this recommendation as long as existing wells were sufficiently placed to address this question.*
- No further action for soils at SA 01 and Site 02. *The team agreed with the recommendation for SA 01.*
- Residual soil contamination (polychlorinated biphenyl [PCB] contamination) at SA 04 be addressed in a Focused Feasibility Study (FFS) for the CED area.
- R. Gottlieb's e-mail correspondence of November 8<sup>th</sup>, 2013 raised several RIDEM concerns (see **Attachment D**). In summary, RIDEM is particularly concerned with residual lead and/or TPH contamination at Sites 02/03 and SA 04. For example, R. Gottlieb indicated that the residual TPH and lead concentrations at Site 02 (*after* the removal actions) exceed residential and industrial



DECs. RIDEM is requesting additional soil sampling at Sites 02 and 03 (lead and TPH sampling), and SA 04 (lead sampling) to resolve contamination questions or that a residential land use restriction be placed on these areas. RIDEM would also accept "pavement" (to be maintained) to prevent direct contact exposure and limit contaminant migration in these areas (i.e., soil excavation would not necessarily be required). It should be noted that, regarding leachability concerns, the groundwater underlying the CED area sites is actually classified GB. However, R. Gottlieb stated that while the groundwater underlying the site is indeed classified as GB, exceedances of GA criteria would be a concern to the State if the groundwater flowed into and potentially impacted a GA area (e.g., north of the CED area sites).

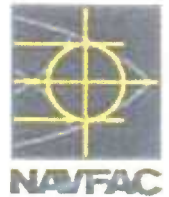
- Navy will forward a sampling proposal to the team by December 12<sup>th</sup>, 2013. If additional wells are recommended for the CED area, they will be installed by Tetra Tech EC; sampling would be conducted by Tetra Tech NUS.

The next BCT teleconference is scheduled for December 11<sup>th</sup>, 2013 at 10 AM.

**ATTACHMENT A**

**AGENDA**





**AGENDA**  
**FORMER NCBC DAVISVILLE**  
**BRAC Cleanup Team (BCT Teleconference)**

Call in # 1-866-692-5721

Participant Code: 9158476

**Date: November 12, 2013**

**Time: 10:00 AM to Noon**

**Discussion Lead: Jeff Dale**

**AGENDA**

**1) Introduction**

**Goals:**

- a. Review outstanding Action Items from September 5

**2) CED Area Drum removal status**

**Goals:**

- a. Update Team on progress of drum removal, soil sampling, and disposal
- b. Agree on locations of monitoring wells. (Note 1)

**3) Path Forward for CED Area**

**Goals:**

- a. Identify what can be completed while waiting for all data from drum removal
  - i. Finalize Human Health Risk Assessment (SA1&4 Sites 2&3)
  - ii. Discuss soil compliance with RIDEM 8.10 (Note 1)
  - iii. Identify soil/groundwater data gaps for FFS/early action (other than drum burial data)
    - 1. TPH in soil at site 3
    - 2. Leachability concerns

**4) Site 16 Status:**

**Goal: Establish schedule for ROD signature date.**

- a. Public comment period closes November 14
- b. Draft ROD & responsiveness summary 45 days after (December 30)



**5) QDC-1 Wetland Status:**

**Goal: Update Team.**

- a. Schedule for Maintenance cleaning of pipe
- b. Schedule for RI field work
- c. CZM consistency submission

**6) Wrap Up**

**Goals:**

- a. Agree on action items from this call
- b. Confirm date and agenda of next call

Note 1: Supporting information is provided via adobe connect NCBC Davisville site.  
<https://epa.connectsolutions.com/davisville/>

**Action Items from September 5, 2013**

**See separate file**

## **ATTACHMENT B**

### **UPDATED ACTION ITEMS**



## UPDATED ACTION ITEMS FROM THE 12<sup>th</sup> NOVEMBER 2013 BCT TELECONFERENCE FORMER NCBC DAVISVILLE

### NEXT TELECONFERENCE:

The next BCT teleconference is set for Wednesday, December 11<sup>th</sup>, 2013, 10 AM till noon.

### Action Items:

Status of August 13, 2013 Items (Pending items are highlighted in yellow; all other Aug 13<sup>th</sup> items completed):

Status	Date Completed	Item
Done	8/19/13	1) Send CED Area Geophysical Report to BCT. (ASAP) (J Dale).
Done	8/14/13	2) Send June 11, 2013 BCT teleconference notes to BCT. (ASAP) (J Dale).
Done	8/26/13	3a) Send RTCs for regulatory comments received on work plans for QDC outfall RI.
Done	9/18/13	3b) Provide schedule for RTC for QDC-1 pipe cleaning (Aug 26th) (J Dale/R Shoemaker).
Revised target submission date for report is 12/6/13		4) Send schedule for submittal of Site 09 Annual Report (including shellfish consumption human health risk assessment) (J Dale/S Anderson). (Item revised 11_12_13)
Done	8/20/13	5) Send RTCs for EPA June proposal regarding the synoptic GW events for Site 07. Include proposal for decrease in well numbers to counter-balance need for synoptic event.
Done.	9/05/13	6) Send missing table from Feb 19 E-mail that further identified EPA recommendations regarding LTM sampling at Site 09. (ASAP) (Christine Williams). NOTE: This was an internal table and will not be distributed.
Done	9/05/13	7) Review and prepare response to EPA Feb 19th E-mail (including response to items on missing table for Site 09). Monitoring at Location 10S? Monitoring at piezometer location 05 (including co-located sediments)? Analytical program for co-located SD/shellfish/piezometer?(Aug 20th in prep for Sept 5 teleconference) (J Dale/S Anderson).
Done	8/13/13	8) Complete internal ARAR discussions for Site 16 based on July



		31, teleconference. (Aug 14)(D Barney/E Balsamo).
Done	8/20/13	9) Add summary bullets from July 9, 2013 teleconference to BCT teleconference notes of Aug 13. (Aug 20) (LA Sinagoga).
Done	9/11/13	10) Send CED area drum removal work plan to BCT. (J Dale)
Done	8/22/13	11) Send follow-up RTCs and DF version of PP/FSA for Site 16. (Sept 6th or 13th.) (LA Sinagoga)
Done	8/15/13	12) Check out Pb units for CED Study Area 04 (LA Sinagoga).
Done	8/15/13	13) Send Excel tables of CED area data to Rich Gottlieb (LA Sinagoga).
Done	8/22/13	14) Send Dave Peterson's ARARs tables for the Site 07 ESD. (Aug 19) (C Williams)
Revised target date is 11/29/13		15) Send RTCs on EPA ESD comments. ESD comments currently being reviewed by Navy attorney. (Item revised 11_12_13) (J Dale/R Shoemaker)
Done	8/19/13	16) Send RTCs on EPA comments on geophysics work plan for CED area. (Sept 13 email) (J Dale)

September 5, 2013 Items (Pending items are highlighted in yellow; all other Sept 5<sup>th</sup> items completed):

Status	Date Completed	Item
Done		1) Navy (LA Sinagoga) will finalize BCT teleconference notes of 6.11.13, 7.31.13, and 8.13.13 with consideration of the RIDEM comments received in E-mails of 8.14.13 and 8.21.13. (Target date = 9.13.13.)
Done	9/18/13	2) Navy (J Dale and S Anderson) will update and forward Site 07 LTM table and "level of interpretation" agreements per BCT discussions of 9.5.13. (Target date = 9.10.13.)
Done	9/18/13	3) Navy (J Dale and S Anderson) will update and forward Site 09 LTM table and "level of interpretation" agreements per BCT discussions of 9.5.13. (Target date = not specified??)
Revised target date = 12/11/13		4) EPA (W. Brandon) will make recommendation regarding when to collect synoptic water level measurements (incoming or outgoing tide? Low, mid, or high tide?). (Item revised 11_12_13)
Completed		5) Navy (R. Shoemaker) will conduct Fall LTM for Sites 07 and 09. (Target date = Sept/Oct timeframe.)
Completed		6) Navy (Dave Barney) will confirm Site 16 Public Hearing



		date of 10.24.13 and associated logistics. (Target date = not specified.)
Completed	9/18/13	7) Navy (LA Sinagoga and J Logan) will publish <b>Final?</b> FSA and PP documents for Site 16. (Target date = not specified, pending OK from Navy legal?)
Done	9/19/13	8) Navy will cancel Sept RAB..... to be reschedule in Oct. (Target date = not specified.)
Done	9/16/13	9) Navy (R. Shoemaker) to verify that the Site 09 flush mount wells are accessible. (Target date = not specified.)

### New Action Items Developed During November 12<sup>th</sup>, 2013 BCT Call:

Status	Date Completed	Item
Target Date not specified		1) Advise Jeff Dale regarding any EPA concerns/comments regarding QDC RI Work Plan. (C Williams)
As is necessary.		2) Share weekly updates regarding field work accomplished at CED area sites and QDC Wetland. (J Dale)
Target Date: Mid December		3) Prepare/submit sampling proposal for CED (Sites 1 through 4). (J Dale/ Tt)

**ATTACHMENT C**

**PROPOSED WELL CLUSTERS -  
CED AREA**



# NOTES

## LEGEND

1. ROADS
2. FENCE
3. CONTOURS
4. AREA OF GEOPHYSICAL SURVEY
5. PRISM TELL SITE BOUNDARY
6. INFERRED DRUM LOCATION

PROPOSED  
WELL CLUSTER

INFERRED BURIED  
DRUM LOCATION

empty drum

buried iron pipe

intact drum and  
crushed drums

NAVFAC

PRISM TELL  
SITE MAP  
FORMER NAVAL CORP. ORIENTAL  
BATTLE CENTER, DAVENPORT

REVISION:  
AUTHOR: A. CRABTREE  
PROJECT NO.  
FILE: SEE BELOW

TC

DATE: 11/11/11





**ATTACHMENT D**

**RIDEM SECTION 8.10**

**DISCUSSIONS FOR CED AREA SOILS**

## Sinagoga, Lee Ann

---

**From:** Richard Gottlieb <richard.gottlieb@DEM.RI.GOV>  
**Sent:** Friday, November 08, 2013 2:15 PM  
**To:** Jeffrey.m.dale@navy.mil; williams.christine@epa.gov; david.a.barney@navy.mil; Sinagoga, Lee Ann  
**Cc:** Matthew Destefano; Richard Gottlieb  
**Subject:** FW: Davisville BCT agenda (draft) for November 12, 2013  
**Attachments:** Discussion Points drum area monitoring wells docx; Revised Site 1-4 soil vs RIDEM 8.10.xlsx

Jeff,

RIDEM has reviewed the table that the Navy prepared to compare sampling results for Sites 1, 2, 3 and 4 to Section 8.10 of the RIDEM Remediation Regulations, Amended November 2011 and have the following comments:

Site 1 - There were 29 sample locations of which 3 exceeded for chrysene (400 ug/kg), however location 1-SS7A-S1 at 410 was a U value. There were 8 exceedances for BaP (eq) for which the Navy has a standard of 400 that ranged from 411 to 945.

Site 2 - The Navy only evaluated subsurface soils. For residential land use purposes RIDEM considers the soil column from the surface to the water table. Based on the "Close-Out Report for TCRA NCBC Site 02 (Battery Acid Disposal Area) 9/96 by Foster Wheeler Environmental Corp. 30 confirmatory samples were taken which yielded 24 lead samples and 28 TPH samples (at some locations only one constituent was sampled for). 6 of the 24 lead samples exceeded the RIDEM RDEC and 6 TPH samples exceeded the RIDEM RDEC of 500 ppm. 4 lead samples and 1 TPH sample exceeded the RIDEM I/CDEC of 400 ug/kg and 2500 mg/kg, respectively. This is what was left in the ground after the removal action.

In addition, there were 16 other soil samples that were taken as part other investigations of the site. These results showed 2 samples exceeding TPH (66B1SB-2-4 @ 1300J and 66MW1SB-2-4 at 780J) and two samples of manganese that were greater than 5 times the residential standard of 390 at locations B-02-10-08S (1520) and B-02-08-04S (2980).

Based on the above Site 2 does not meet the requirements for section 8.10 of the RIDEM Remediation Regulations.

Site 3 - There were 11 sample locations for TPH all of which exceed the RIDEM RDEC, 10 of which exceed the RIDEM I/CDEC and one sample which exceeds the upper concentration limit of 30,000 mg/kg. There were 6 soil samples which exceed the RIDEM RDEC ranging from 152 to 628 mg/kg. RIDEM concurs with the Navy recommendation to address TPH, but would also recommend that lead also be addressed. Based on the above Site 3 does not meet the requirements of Section 8.10 of the RIDEM Remediation Regulations.

Site 4 - There was only one exceedance of RIDEM RDEC for lead at location SS-4A at 777 mg/kg which is also greater than 5 times the RDEC of 150 mg/kg. This should be addressed. Based on the above Site 4 does not meet the requirements of Section 8.10 of the RIDEM Remediation Regulations.

RIDEM would further like to discuss these site with the Navy and USEPA.

Richard Gottlieb, P.E.  
Principal Engineer

Rhode Island Dept. of Environmental Management  
Office of Waste Management  
235 Promenade Street  
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-----Original Message-----

From: Dale, Jeffrey M CIV NAVFAC MIDLANT, EV [<mailto:jeffrey.m.dale@navy.mil>]  
Sent: Wednesday, November 06, 2013 2:02 PM  
To: Williams, Christine ([williams.christine@epa.gov](mailto:williams.christine@epa.gov)); Richard Gottlieb  
Cc: Barney, David A CIV NAVFACHQ, BRAC PMO; Sinagoga, Lee Ann; Anderson, Scott ([Scott.Anderson@tetrattech.com](mailto:Scott.Anderson@tetrattech.com)); Logan, Joe; Shoemaker, Robert; Pinkham, Derek ([Derek.Pinkham@tetrattech.com](mailto:Derek.Pinkham@tetrattech.com)); [glucksman@mabbett.com](mailto:glucksman@mabbett.com); Brandon, William ([Brandon.Bill@epa.gov](mailto:Brandon.Bill@epa.gov)); [jforan@maine.rr.com](mailto:jforan@maine.rr.com); Patty Dunn ([Patty.Dunn@mgtedge.com](mailto:Patty.Dunn@mgtedge.com))  
Subject: RE: Davisville BCT agenda (draft) for November 12, 2013

All

I loaded two additional documents to the adobe connect site. One is an updated table comparing Site/Study Area 1-4 soil data to RIDEM DEC to evaluate compliance with RIDEM section 8.10. The table now also compares to relevant EPA RSLs (there were no errors on the table, only the additional comparison). There is also a file with a revised proposal for monitoring wells in the CED drum removal area. Since they are small files, they are also attached.

If you download the large file with potentiometric surface maps, please use caution if trying to print it. The "shrink to fit" of the D size drawings to 8.5x11 may cause problems.

Jeff

-----Original Message-----

From: Dale, Jeffrey M CIV NAVFAC MIDLANT, EV

Sent: Tuesday, November 05, 2013 6:26 PM

To: Williams, Christine ([williams.christine@epa.gov](mailto:williams.christine@epa.gov)); Richard Gottlieb

Cc: Barney, David A CIV OASN (I&E) BRAC PMO NE; Sinagoga, Lee Ann; Anderson, Scott ([Scott.Anderson@tetrattech.com](mailto:Scott.Anderson@tetrattech.com));

Logan, Joe; Shoemaker, Robert; Pinkham, Derek ([Derek.Pinkham@tetrattech.com](mailto:Derek.Pinkham@tetrattech.com)); [glucksman@mabbett.com](mailto:glucksman@mabbett.com); Brandon,

William ([Brandon.Bill@epa.gov](mailto:Brandon.Bill@epa.gov)); [jforan@maine.rr.com](mailto:jforan@maine.rr.com)

Subject: Davisville BCT agenda (draft) for November 12, 2013

Christine and Richard

Attached is a draft agenda for the BCT next week. Let me know if you have any suggestions (in redline  
strikeout). Also, please forward to anyone I omitted from distribution.

Thanks

Jeff

TABLE XX

COMPARISON OF CED AREA DATABASE TO SECTION 8.10 CRITERIA OF RIDEM'S REMEDIATION REGULATIONS  
HUMAN HEALTH RISK RATIO EVALUATION  
FORMER NCBC DAVISVILLE  
NORTH KINGSTOWN, RHODE ISLAND  
PAGE 1 OF 3

Data Set Evaluated	Are Residential DEC's Exceeded? If so, for what chemical(s)? <sup>(2)</sup>		Are 20 or More Samples Included? <sup>(2)</sup>	Do Any Samples Exceed the Residential DEC by a Factor of 5? <sup>(3)</sup>		Do more than 10% of Sample Results Exceed the Residential DEC? <sup>(4)</sup>		Are Industrial DEC's Exceeded? If so, for what chemical(s)? <sup>(2)</sup>		Do Any Samples Exceed the Industrial DEC by a Factor of 5? <sup>(3)</sup>		Do more than 10% of Sample Results Exceed the Industrial DEC? <sup>(4)</sup>		Conclusions
Study Area 01 Surface Soil	Yes	BAP (Max = 0.53; DEC = 0.4)	Yes (29 Samples)	No	BAP: 5x DEC = 2.65	No	BAP: 2 of 29 (6.9%) of samples exceed DEC.	No	No	Not Applicable	Not Applicable	Not Applicable	Industrial DEC's were not exceeded. Conditions of Section 8.10 are met for chemicals exceeding Residential DEC's. <i>Therefore no further action recommended.</i>	
		No		Chrysene: 5x DEC = 2.65	No	Chrysene: 2 of 29 (6.9%) of samples exceed DEC.								
		No		Pb: 5x DEC = 750	No	Pb: 1 of 29 (3.4%) of samples exceed DEC.								
Study Area 01 Subsurface Soil	Yes	Mn (Max = 535; DEC = 390) <i>USEPA Res RSL =1,800 mg/kg</i> .	No (9 Samples)	No	Mn: 5x DEC = 1950	Yes	Mn: 2 of 9 (22%) or samples exceed DEC.	No	Not Applicable	Not Applicable	Not Applicable	Industrial DEC's were not exceeded. Less than 20 samples are included in the data set, and manganese exceeds the residential DEC in more than 20% of samples. Therefore, conditions of Section 8.10 are not met for Residential DEC's. However, the maximum manganese concentration is less than EPA RSL. <i>Therefore, no further action is recommended.</i>		
Site 02 Surface Soil	No		Not Applicable	Not Applicable		Not Applicable		No	Not Applicable	Not Applicable	Not Applicable	Residential and Industrial DEC's were not exceeded.		

TABLE XX

COMPARISON OF CED AREA DATABASE TO SECTION 8.10 CRITERIA OF RIDEM'S REMEDIATION REGULATIONS  
HUMAN HEALTH RISK RATIO EVALUATION  
FORMER NCBC DAVISVILLE  
NORTH KINGSTOWN, RHODE ISLAND  
PAGE 2 OF 3

Data Set Evaluated	Are Residential DEC's Exceeded? If so, for what chemical(s)? <sup>(1)</sup>		Are 20 or More Samples Included? <sup>(2)</sup>	Do Any Samples Exceed the Residential DEC by a Factor of 5? <sup>(3)</sup>		Do more than 10% of Sample Results Exceed the Residential DEC? <sup>(4)</sup>		Are Industrial DEC's Exceeded? If so, for what chemical(s)? <sup>(1)</sup>		Do Any Samples Exceed the Industrial DEC by a Factor of 5? <sup>(3)</sup>		Do more than 10% of Sample Results Exceed the Industrial DEC? <sup>(4)</sup>		Conclusions
Site 02 Subsurface Soil	Yes	Sb (Max = 12.2; DEC = 10) <i>USEPA Res RSL = 31 mg/kg.</i>	Yes for Pb (29 samples) and TPH (31 samples); No for other metals (12 samples)	No	Sb: 5x DEC = 50	No	Sb: 1 of 12 (8.3%) of samples exceed DEC.	Be (Max = 3.5; DEC = 1.5)	No	Be: 5x DEC = 7.5	No	Be: 1 of 12 (8.3%) of samples exceed DEC.	Conditions of Section 8.10 are met for TPH exceeding the Residential DEC. Conditions of Section 8.10 are met for Pb for the Industrial DEC. Conditions of Section 8.10 are not met for Pb exceeding the Residential DEC because more than 10% of Pb results exceed the Residential DEC. Less than 20 samples are included in the data set for the other four metals exceeding the Residential DEC and one metal exceeding the Industrial DEC; therefore, the conditions of Section 8.10 are not met for these exceedances. However, Sb, Be, and Cd concentrations do not exceed EPA Res RSLs. Slightly marginal exceedance of EPA Res RSLs for Pb and Mn. Based on these results and the risk assessment results, no further action is recommended.	
		Be (Max = 3.5; DEC = 1.5) <i>USEPA Res RSL = 160 mg/kg.</i>		No	Be: 5x DEC = 7.5	No	Be: 1 of 12 (8.3%) of samples exceed DEC.							
		Cd (Max = 48.8; DEC = 39) <i>USEPA Res RSL = 70 mg/kg.</i>		No	Cd: 5x DEC = 195	No	Cd: 0 of 12 (0%) of samples exceed DEC. <sup>(5)</sup>							
		Pb (Max = 625; DEC = 150) <i>USEPA Res RSL = 400 mg/kg.</i>		No	Pb: 5x DEC = 750	Yes	Pb: 6 of 29 (21%) of samples exceed DEC.	Pb (Max = 625; DEC = 500)	No	Pb: 5x DEC = 2500	No	Pb: 3 of 29 (10%) of samples exceed DEC.		
		Mn (Max = 2980; DEC = 390) <i>USEPA Res RSL = 1,800 mg/kg.</i>		Yes	Mn: 5x DEC = 1950	Yes	Mn: 2 of 12 (17%) of samples exceed DEC.							
		TPH (Max = 1300; DEC = 500)		No	TPH: 5x DEC = 2500	No	TPH: 2 of 31 (3.2%) of samples exceed DEC.							
Site 02 Deep Subsurface Soil	No		Not Applicable	Not Applicable		Not Applicable		No		Not Applicable		Not Applicable		Residential and Industrial DEC's were not exceeded.
Site 03 Surface Soil	Yes	Pb (Max = 628; DEC = 150) <i>USEPA Res RSL = 400 mg/kg.</i>	Yes for Pb (30 samples); No for TPH (11 samples)	No	Pb: 5x DEC = 750	Yes	Pb: 6 of 30 (20%) of samples exceed DEC.	Yes	Pb (Max = 628; DEC = 500)	No	Pb: 5x DEC = 2500	No	Pb: 1 of 30 (3.3%) of samples exceed DEC.	Conditions of Section 8.10 are met for Pb exceeding the Industrial DEC. Conditions of 8.10 are not met for Pb exceeding the Residential or Industrial DEC's. However, marginal exceedance of USEPA RSL for Pb in soils. <b>Further action recommended for TPH only.</b>
		TPH (Max = 57,000; DEC = 500)		Yes	TPH: 5x DEC = 2500	Yes	TPH: 11 of 11 (100%) of samples exceed DEC.	Yes		TPH (Max = 57,000; DEC = 2500)		Yes		
Site 03 Subsurface Soil	No		Not Applicable	Not Applicable		Not Applicable		No		Not Applicable		Not Applicable		Residential and Industrial DEC's were not exceeded.

TABLE XX

COMPARISON OF CED AREA DATABASE TO SECTION 8.10 CRITERIA OF RIDEM'S REMEDIATION REGULATIONS  
HUMAN HEALTH RISK RATIO EVALUATION  
FORMER NCBC DAVISVILLE  
NORTH KINGSTOWN, RHODE ISLAND  
PAGE 3 OF 3

Data Set Evaluated	Are Residential DEC's Exceeded? If so, for what chemical(s)? <sup>2(1)</sup>		Are 20 or More Samples Included? <sup>2(2)</sup>	Do Any Samples Exceed the Residential DEC by a Factor of 5? <sup>3(3)</sup>		Do more than 10% of Sample Results Exceed the Residential DEC? <sup>4(4)</sup>		Are Industrial DEC's Exceeded? If so, for what chemical(s)? <sup>2(2)</sup>		Do Any Samples Exceed the Industrial DEC by a Factor of 5? <sup>3(3)</sup>		Do more than 10% of Sample Results Exceed the Industrial DEC? <sup>4(4)</sup>		Conclusions
Site 03 Deep Subsurface Soil	Yes	Mn (Max = 1330; DEC = 390) USEPA Res RSL = 1,800 mg/kg.	No (11 samples)	No	Mn: 5x DEC = 390	Yes	Mn: 2 of 11 (18%) of samples exceed DEC.	No		Not Applicable		Not Applicable		Industrial DEC's were not exceeded. Conditions of Section 8.10 were not met for manganese exceeding the Residential DEC. However, max Mn concentration does not exceed USEPA Res RSL. Therefore, no further action recommended.
Study Area 04 Surface Soil	Yes	Sb (Max = 14.1; DEC = 10) USEPA Res RSL for Sb = 31 mg/kg.	No for Sb (12 samples); Yes for Pb (25 samples)	No	Sb: 5x DEC = 50	No	Sb: 1 of 12 (8.3%) of samples exceed DEC.	Yes	Pb (Max = 777; DEC = 500)	No	Pb: 5x DEC = 2500	No	Pb: 2 of 25 (8%) of samples exceed DEC.	Section 8.10 conditions are met for Pb exceeding the industrial DEC. Section 8.10 conditions were not met for the Residential DEC exceedances. However, marginal exceedance of USEPA RSL for Pb in soils. <i>Risk assessment recommended further action based on low-level polychlorinated biphenyl compounds (PCBs) in surface soils.</i>
	Yes	Pb (Max = 777; DEC = 150)		Yes	Pb: 5x DEC = 750	Yes	Pb: 3 of 25 (12%) of samples exceed DEC.							
Study Area 04 Subsurface Soil	Yes	Mn (Max = 1090; DEC = 390) USEPA Res RSL for Mn = 1,800 mg/kg.	No (7 samples)	No	Mn: 5x DEC = 1950	Yes	Mn: 1 of 7 (14%) of samples exceed DEC.	No		Not Applicable		Not Applicable		Industrial DEC's were not exceeded. Conditions of Section 8.10 were not met for manganese exceeding the Residential DEC. However, max Mn concentration does not exceed USEPA Res RSL. Therefore, no further action recommended.

All concentrations are in mg/kg.

1 - DEC source: Rhode Island Department of Environmental Management (RIDEM), DEM-DSR-01-93, November 2011.

2 - According to Section 8.10 of RIDEM's *Remediation Regulations* (November 2011), if at least 20 samples are collected, statistical methodology can be used for determining compliance.

3 - A criterion listed in Section 8.10 is that "no single sample result exceeds the soil objective by a factor of 5."

4 - An additional criterion listed in Section 8.10 is that "no more than 10% of the individual sample results exceed the soil objective."

5 - The exceedance was noted in an original sample of a field duplicate pair; the average of the original and duplicate samples, used to determine the frequency of exceedance, did not exceed the DEC.

## **APPENDIX C**

### **TIME-CRITICAL REMOVAL ACTION MEMORANDUM**



## **ACTION MEMORANDUM**

**DATE:** December 20, 2013

**FROM:** David A. Barney, BRAC Environmental Coordinator,  
Naval Construction Battalion Center, Davisville, Rhode Island

**SUBJECT:** Time Critical Removal Action  
Drum Burial Area within the Construction Equipment Department Area  
Naval Construction Battalion Center, Davisville, Rhode Island

### ***1.0 PURPOSE***

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The purpose of this Action Memorandum is to document the decision by the Department of the Navy (Navy) to conduct a Time Critical Removal Action (TCRA) to remove buried drums and characterize adjacent soil from the Construction Equipment Department (CED) Area at Naval Construction Battalion Center (NCBC), Davisville, Rhode Island.

This TCRA is being conducted to reduce potential risks to public health, welfare, and the environment posed by the drums. The CED area contains Study Area 1 (former CED drum storage area), Site 2 (battery acid disposal area), Site 3 (solvent disposal area), and Study Area 4 (asphalt disposal area). These sites and study areas are collectively managed as Operable Unit-7 (OU-7).

These drums appear to represent a distinct and previously unidentified disposal event, and are not within the boundaries of these previously identified sites or study areas within the CED Area. They will be identified as the “drum burial area” until a determination is made of the status of this drum burial area in regards to site or OU status. That decision will be made in consultation with the U.S. Environmental Protection Agency (EPA) and the Rhode Island Department of Environmental Management (RIDEM) in accordance with Section XXXI “Identification of Study Areas” of the Federal Facilities Agreement (FFA) dated March 23, 1992.

The Department of Defense (DoD) has the authority to undertake Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) response actions, including removal actions, under Title 42 of the United States Code (U.S.C.) Section (§) 9604, 10 U.S.C. § 2705, and federal Executive Orders 12580 and 13016. There are no nationally significant or precedent-setting issues for this removal action.

The drums were removed during this TCRA, and the preparation of closeout documentation is underway. Mobilization for the removal action occurred on 21 October 2013. The excavation of

the drums was completed on 25 October 2013. Soil from beneath the drums was sampled for laboratory analysis to evaluate the potential for contamination remaining at the burial area.

## ***2.0 NCBC DAVISVILLE BACKGROUND***

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NCBC Davisville is located in the Town of North Kingstown, Rhode Island, approximately 18 miles south of the state capital, Providence. The Navy acquired the adjacent property in 1939 and built Naval Air Station (NAS) Quonset Point. By 1942, this property was developed for training activities, including the NCBC at Davisville. After World War II, the NAS remained in operation, but the NCBC was inactive until 1951 when the activity was designated Naval Construction Battalion Center Headquarters. Operations at NCBC Davisville were subsequently reduced in 1974. NCBC Davisville was selected for closure in 1991, was decommissioned on March 25, 1994, and was officially closed on April 1, 1994.

NCBC Davisville was placed on the EPA National Priorities List (NPL) on November 21, 1989. In response to the NPL listing, the FFA was established in 1992 between the Navy, the EPA and RIDEM to coordinate investigation and remedial response activities to be conducted at the former NCBC Davisville under the Navy's Installation Restoration Program (IRP) program and CERCLA.

The CED area is in the remedial investigation/ feasibility study (RI/FS) phase of CERCLA and there is no Record of Decision (ROD) for this OU. The CED area is within Parcel 7, which is retained by the Navy pending completion of all necessary remedial action to protect human health and the environment.

## ***3.0 SITE DESCRIPTION***

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This section presents a summary of the environmental conditions at the drum burial site and at OU-7 in general. The OU-7 conditions have been evaluated through several previous and ongoing investigations as discussed below.

### **a. BACKGROUND.**

The CED Area (OU-7) is located north of Davisville Road in the northern portion of Parcel 7. Calf Pasture Point is bounded to the south by Davisville Road, to the east by Marine Road, to the north by Perimeter Road and to the west by Seabee Avenue. The CED Area is in an upland portion of the former NCBC Davisville and was used for operations and storage of equipment. The former Building 224 housed the CED operations. A site map and location of the removal action and nearby study areas/sites is included in Figure 1. These sites and study areas are within Navy Parcel 7, which is currently leased to the Quonset Development Corporation (QDC) under a Lease in Furtherance of Conveyance (LIFOC, N62472-98-RP-00035). QDC discovered

several buried drums in April, 2013 while attempting to unearth a large boulder for crushing to facilitate future development of the CED Area.

One drum was punctured upon discovery, and a liquid that appeared to be oil leaked from the drum. QDC emptied the contents into a second drum and stored it in a maintenance facility. A small amount of soil was impacted by the liquid. This soil was excavated, placed on polyethylene sheeting and covered. Additional buried drums were visible in the excavation around the boulder. QDC notified the Navy and ceased activities in the area. The Navy characterized the drum contents as waste oil and various solvents, and later disposed of the drum contents as hazardous waste. To prevent exposure through contact the excavation that revealed the drums was backfilled.

In June, 2013, a geophysical survey was conducted within a 200 by 300 foot area centered on the boulder to assess the immediate extent of the buried drums for removal consideration. The survey identified 11 features that could represent additional drums buried in the vicinity of the boulder.

In October, 2013, the drums were excavated, removed and staged for disposal. Soil was sampled to characterize conditions in the drum burial area. These additional drums were determined to be empty and/or crushed; and they were staged for disposal along with other metallic debris collocated with the drums.

As of November, 2013 the analytical results of soil sampling are pending. Groundwater wells are planned to evaluate conditions in the vicinity of the excavation

**b. SITE EVALUATION.**

Previous evaluations of the CED Area summarized in the table below did not reveal that drums were buried at this location. Additional details can be found in the Administrative Record.

YEAR	ACTIVITY
1984	Basewide Initial Assessment Study
1987	Basewide Confirmation Study
1995	Basewide Environmental Baseline Survey
1998-present	Remedial Investigation / Feasibility Study (ongoing)
1997	Finding of Suitability to Lease Parcel 7
1998	Lease to Quonset Development Corporation
2013	Identification of Buried Drums and Time Critical Removal Action



**c. RELEASE OR THREATENED RELEASE INTO THE ENVIRONMENT OF A HAZARDOUS  
SUBSTANCE, OR POLLUTANT OR CONTAMINANT.**

The buried drums were unexpectedly discovered in an area not subject to investigation or intrusive sampling. The observation of additional drums of unknown quantity or content could present a potential hazard to human contact or further deterioration and release of unknown contents to the environment.

**d. NATIONAL PRIORITIES LIST (NPL) STATUS.**

The former NCBC Davisville was placed on the NPL in November 1989 by EPA pursuant to CERCLA (CERCLIS ID No. RI6170022036). During its operational period, NCBC Davisville was owned by the U.S. Government, and was operated by the Department of the Navy. Therefore, the Navy is required to take response actions pursuant to CERCLA and the terms of the FFA.

## ***4.0 OTHER ACTIONS TO DATE***

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**a. PREVIOUS ACTIONS.**

No other removal actions have been conducted to date at the drum burial area.

**b. INVESTIGATIONS AND ASSESSMENTS.**

Several investigations have been conducted at the CED Area as noted in Section 3b of this document, above. The immediate vicinity of the drum burial area has not been subject to investigation.

**c. CURRENT ACTIONS.**

The excavated drums have been characterized for disposal, soil sampling has been conducted and results are pending. The Navy will share the results of soil and groundwater sampling and evaluate the site for future action.

## ***5.0 STATE AND LOCAL AUTHORITIES ROLE***

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**a. STATE AND LOCAL ACTIONS TO DATE.**

The Navy is the lead federal agency at NCBC Davisville pursuant to the Defense Environmental Restoration Act at 10 U.S.C §§ 2701 through 2710 and CERCLA, the NCP, and the delegation of Presidential authority under federal Executive Orders 12580 and 13016. Pursuant to 10 U.S.C. § 2705, the Navy is required to ensure that state and local officials be given timely opportunity to review and comment on the Navy's response actions. State and local authorities

have not undertaken any removal actions at the drum burial area; however, they provide oversight of studies and actions conducted by the Navy. The EPA and RIDEM provide oversight of actions and review of documents for NCBC Davisville. They were notified when the drum burial area was discovered and were consulted prior to mobilization for the TCRA field work.

The local community has been involved in the site investigation and remediation processes at NCBC Davisville through use of Technical Review Committees, Restoration Advisory Board (RAB) meetings, press releases, Fact Sheets, and public meetings. RABs are currently conducted approximately twice per year. Notification of this removal action and this action memorandum will be provided to the public in the North Kingston Times.

No enforcement orders or agreements have been issued that are relevant to this TCRA.

**b. POTENTIAL FOR CONTINUED STATE AND LOCAL RESPONSE.**

The EPA and RIDEM will continue to oversee the investigations and removal actions and the local community will continue to provide input on actions conducted at OU-7 through the RAB.

## ***6.0 THREATS TO PUBLIC HEALTH OR WELFARE OR THE ENVIRONMENT, AND STATUTORY AND REGULATORY AUTHORITIES***

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Potential threats to public health, welfare or the environment posed by site contaminants, and statutory and regulatory authorities that apply to the drum burial area are discussed in this section.

**a. THREATS TO PUBLIC HEALTH OR WELFARE.**

The buried drums pose a risk to human health because they contained unknown contents. Therefore, removal of the buried drums will reduce the potential human health risks at the drum burial area by eliminating the potential for exposure via direct contact to their contents. This removal action will also eliminate a potential source of soil or groundwater contamination.

**b. THREATS TO THE ENVIRONMENT.**

The primary threats to public health (direct contact with the drum contents) could also pose a risk for ecological receptors.

**c. REGULATORY AUTHORITIES.**

The EPA enforces cleanup of CERCLA sites where exposure is found to result in elevated risk to human or environmental receptors. Both the EPA and RIDEM will oversee the TCRA and any follow up action.

## **7.0 ENDANGERMENT DETERMINATION**

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Actual or threatened releases of pollutants and contaminants from the drum burial area, if not addressed by implementing the response action selected in this Action Memorandum, may present an imminent and substantial endangerment to public health, or welfare, or the environment. The Navy has determined that this threat can be abated, minimized, or eliminated by undertaking a TCRA.

## **8.0 PROPOSED ACTIONS AND ESTIMATED COSTS**

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This section describes the ongoing and proposed TCRA actions to mitigate the conditions cited in Section 6 of this document, above. This section also discusses ARARs and presents the estimated costs for the TCRA.

### **a. PROPOSED ACTION.**

The proposed TCRA consists of excavation, transportation, and off-site disposal of the drums and their contents. Following excavation, confirmatory soil samples were collected from beneath the drums and at other locations in the immediate vicinity. This work has already been completed as of November, 2013.

Public notification of this TCRA was provided via legal notice published in the local newspaper on the week of January 6, 2014. The legal notice identified the availability and location of this Action Memorandum for public review. Comments received from the EPA and RIDEM on the Removal Action Work Plan were received and taken into consideration in support of the TCRA.

The major components of the proposed removal action and the basis for the proposal are provided below. Details of the actions and methods to perform the TCRA were described in a Removal Action Work Plan. This Action Memorandum and the other key documents relating to this TCRA are or will be placed in the local Information Repositories and will be available to the public and to the regulators. The following paragraphs describe the major components of this proposed action.

- *Geophysical Survey – A geophysical survey was conducted on a 200 by 300 foot area around the boulder to identify other potential buried drums. Eleven features were identified for excavation and evaluation.*
- *Removal Action Work Plan – A Removal Action (RA) Work Plan was prepared and submitted. The RA Work Plan described the details of the removal, the schedule, and the sampling to be conducted.*
- *Site Setup – Prior to the start of excavation, staging areas, decontamination areas and site access controls were set up and any buried utilities were located and marked accordingly.*



- Removal Activities – The removal area consisted of three distinct excavations at the locations identified by the geophysical survey. It was determined that the geophysical anomalies were empty drums, crushed drums, and pieces of metal pipe.
- Waste Disposal – The excavated metallic debris was removed and will be disposed as scrap metal. The soil and crushed drum will be disposed of as hazardous waste. The contents of drum originally found have been disposed of as hazardous waste.
- Confirmation Sampling – Confirmation samples were collected from the beneath each drum and at other locations in the immediate area of the drums.
- Site Restoration – The location of each excavated drum was surveyed and a permeable marker liner was placed in the excavation to clearly delineate the excavation extents in the event future action is required. The excavation was backfilled and graded with adjacent soils. The excavated areas and other areas disturbed during the removal action are being restored pending any future actions. All equipment, fencing, and facilities have been removed from the site.
- Monitoring Well (MW) Installation – New monitoring wells will be installed to evaluate if the drums are a source of contamination in groundwater.
- A Removal Action Completion Report (RACR) will be prepared that documents this removal action. The RACR will be prepared in January, 2014 and will be reviewed by the EPA and RIDEM. The RACR will also incorporate any input received from the public review of this AM and will include responses to any significant comments received.

**b. CONTRIBUTION TO REMEDIAL PERFORMANCE.**

This removal action is expected to remove a source of direct exposure to contaminants and a potential source of soil or groundwater contamination at the CED Area. If conditions are encountered after the removal action, or if analytical results reveal levels that warrant additional action(s) at the site, those actions will be evaluated by the Navy, EPA and RIDEM and addressed as necessary to provide protection for human health and the environment.

**c. APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs).**

This removal action is being conducted in accordance with CERCLA, RIDEM Remediation Regulations, and all regulations regarding the excavation, transportation and disposal of hazardous materials/wastes including Resource Conservation and Recovery Act (RCRA) and Department of Transportation requirements. ARARs have or will be attained to the extent practicable, consistent with the National Oil and Hazardous Substance Pollution Contingency Plan and USEPA removal action guidance. See Attachment A.

**d. PROJECT SCHEDULE.**

The buried drums were removed during a one week period in October 2013. The disposal of the excavated metallic debris and soil are underway. Analytical results are pending for consultation

with EPA and RIDEM as of November, 2013. Monitoring wells are expected to be installed in December, 2013, with sampling and analysis to follow.

**e. ESTIMATED COSTS.**

The cost for the proposed removal action is approximately \$320,000. If additional contamination is present that could pose unacceptable risk, additional remedial action may be necessary. There are no long term operation, maintenance, or monitoring costs associated with this removal action.

***9.0 EXPECTED CHANGE IN THE SITUATION SHOULD  
ACTION BE DELAYED OR NOT TAKEN***

If the removal action were not conducted, the buried drums would have remained in place and the public could have been inadvertently exposed to them over time. Releases from the drums could have been a source of soil or groundwater contamination.

***10.0 OUTSTANDING POLICY ISSUES***

None identified at this time.

***11.0 ENFORCEMENT***

The removal action is being undertaken voluntarily by the Navy in accordance with CERCLA and the FFA for NCBC Davisville. The regulatory agencies are anticipated to remain in an oversight role for the duration of the removal action and RACR to ensure compliance with regulations under CERCLA.

Based on the results of the soil and groundwater sampling, EPA and RIDEM will be consulted to make a decision as to whether the drum burial area should be identified as a new site, included within the current OU 7, or closed out with no further action required.



## ***12.0 RECOMMENDATION***

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This Action Memorandum was developed in accordance with current EPA and Navy guidance documents for removal actions under CERCLA (EPA, 1990; Navy, 2006). This Action Memorandum documents, for the Administrative Record, the Navy's decision to undertake a TCRA at OU-7.

The removal of the buried drums will reduce the potential human health and ecological risks of exposure to contaminants at the drum burial area. The Navy, therefore, is implementing, completing and documenting this time critical removal action.

Approvals:



David A. Barney  
BRAC Environmental Coordinator  
NCBC Davisville

12/20/13  
Date

## ***REFERENCES***

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42 U.S.C. § 7401 et seq., Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986.

Department of the Navy, 2006. *Navy Environmental Restoration Program Manual*.

EA Engineering, Science and Technology, 1995, *Final Basewide Environmental Survey, Naval Construction Battalion Center (NCBC), Davisville, North Kingstown, Rhode Island*

U.S. Navy, 1997. *Finding of Suitability to Lease and Environmental Baseline Survey to Lease (EBSL) for 704.15 Acres of Land with Buildings at Naval Construction Battalion Center, Davisville, Rhode Island*.

Tetra Tech, EC 2013, *Draft Work Plan for Time Critical Removal Action/Sampling and Analysis Plan Site 03, Former Naval Construction Battalion Center Davisville, North Kingston, Rhode Island*

U.S. Environmental Protection Agency (EPA), 2009. *Superfund Removal Guidance For Preparing Action Memoranda*. Office of Solid Waste and Emergency Response



DRAWN BY D. COUCH	DATE 06/03/13	<div> TETRA TECH</div> <div>LOCATION OF TIME CRITICAL REMOVAL ACTION FORMER CONSTRUCTION EQUIPMENT DEPARTMENT FORMER NCBC DAVISVILLE NORTH KINGSTOWN, RHODE ISLAND</div>	CONTRACT NUMBER		CTO NUMBER		
CHECKED BY S. ANDERSON	DATE 12/06/13		APPROVED BY		DATE		
REVISED BY D. COUCH	DATE 12/06/13		APPROVED BY		DATE		
SCALE AS NOTED			FIGURE NO. 1				REV 0

LOCATION OF TIME CRITICAL REMOVAL ACTION  
FORMER CONSTRUCTION EQUIPMENT DEPARTMENT  
FORMER NCBC DAVISVILLE  
NORTH KINGSTOWN, RHODE ISLAND

**ATTACHMENT A  
TABLE 1**

**FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs AND TBCs – DRUM REMOVAL AND OFF-SITE DISPOSAL  
CED AREA DRUM REMOVAL - ACTION MEMORANDUM  
NCBC DAVISVILLE  
NORTH KINGSTOWN, RHODE ISLAND  
PAGE 1 OF 2**

<b>Federal</b>				
<b>Requirement</b>	<b>Citation</b>	<b>Status</b>	<b>Synopsis</b>	<b>Evaluation/Action to be Taken</b>
Cancer Slope Factors (CSFs)	-	To Be Considered	Guidance values used to evaluate the potential carcinogenic hazards caused by exposure to contaminants.	Potential risks have been addressed through the removal and off-site disposal of drum contents and visually impacted soil. Analytical results from soil and groundwater will be evaluated to determine if an unacceptable risk exists at the site. If an unacceptable risk is identified, further response action to address site risks will attain (or justify waiver of) this ARAR.
Reference Doses (RfDs)	-	To Be Considered	Guidance values used to evaluate the potential non-carcinogenic hazards caused by exposure to contaminants.	
Guidelines for Carcinogen Risk Assessment	EPA/630/P-03/001F (March 2005)	To Be Considered	Guidance for assessing cancer risk.	
Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens	EPA/630/R-03/003F (March 2005)	To Be Considered	Guidance of assessing cancer risks to children.	

ATTACHMENT A

TABLE 1

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs AND TBCs – DRUM REMOVAL AND OFF-SITE DISPOSAL  
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NCBC DAVISVILLE  
NORTH KINGSTOWN, RHODE ISLAND  
PAGE 2 OF 2

State				
Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
State of Rhode Island Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases (Short Title: Remediation Regulations)	DEM-DSR-01- 93, Section 8.02	Applicable	These regulations set remediation standards for contaminated soil resulting from the unpermitted release of hazardous material in Rhode Island.	Analytical results will be evaluated to determine if an unacceptable risk exists at the site. If an unacceptable risk is identified, further response action to address site risks will attain (or justify waiver of) this ARAR.

**ATTACHMENT A**

**TABLE 2**

**FEDERAL AND STATE LOCATION-SPECIFIC ARARs AND TBCs – DRUM REMOVAL AND OFF-SITE DISPOSAL  
CED AREA DRUM REMOVAL - ACTION MEMORANDUM  
NCBC DAVISVILLE  
NORTH KINGSTOWN, RHODE ISLAND  
PAGE 1 OF 1**

<b>Federal</b>				
<b>Requirement</b>	<b>Citation</b>	<b>Status</b>	<b>Synopsis</b>	<b>Evaluation/Action to be Taken</b>
Coastal Zone Management Act	16 United States Code (U.S.C.) Parts 1451 <i>et seq.</i>	Applicable	Requires that any actions must be conducted in a manner consistent with state-approved management programs.	Applicable coastal zone management requirements were satisfied during the removal action. The removal action had no effect on coastal uses or resources and was consistent with state coastal policies.
<b>State</b>				
<b>Requirement</b>	<b>Citation</b>	<b>Status</b>	<b>Synopsis</b>	<b>Evaluation/Action to be Taken</b>
Coastal Resources Management	Rhode Island General Laws (RIGL) 46-23-1 <i>et seq.</i> and Coastal Resources Management Program	Applicable	Sets standards for management and protection of coastal resources.	Applicable coastal resource management requirements were addressed during the removal action. The removal action had no effect on coastal uses or resources and was consistent with state coastal policies.

**ATTACHMENT A  
TABLE 3**

**FEDERAL AND STATE ACTION-SPECIFIC ARARs AND TBCs – DRUM REMOVAL AND OFF-SITE DISPOSAL  
CED AREA DRUM REMOVAL - ACTION MEMORANDUM  
NCBC DAVISVILLE  
NORTH KINGSTOWN, RHODE ISLAND  
PAGE 1 OF 2**

<b>Federal</b>				
<b>Requirement</b>	<b>Citation</b>	<b>Status</b>	<b>Synopsis</b>	<b>Evaluation/Action to be Taken</b>
Resource Conservation and Recovery Act (RCRA)	42 U.S.C. §§ 6901 et seq.,	Relevant and Appropriate	Rhode Island has been delegated the authority to administer these RCRA standards through its state hazardous waste management regulations. These provisions have been adopted by the State.	Materials excavated during the removal action were analyzed by appropriate test methods and, if applicable, managed in accordance with the substantive requirements of the State hazardous waste regulations.
<b>State</b>				
<b>Requirement</b>	<b>Citation</b>	<b>Status</b>	<b>Synopsis</b>	<b>Evaluation/Action to be Taken</b>
Rules and Regulations for Hazardous Waste Management, Definition of Hazardous Waste	DEM OWM-HW01-07, Rule 3	Applicable	Under State regulation hazardous wastes are defined as any hazardous waste as defined in 40 CFR 261.3. The standards also apply to "Rhode Island Wastes" as defined in the regulations.	These regulations applied when determining whether or not solid waste generated during the removal action was hazardous, either by being listed exhibiting a hazardous characteristic or meeting the definition of a Rhode Island Waste.
Standards for Generators of Hazardous Waste	Rules and Regulations for Hazardous Waste Management, Section 5.00	Applicable	Establishes manifesting, pre-transport, and recordkeeping requirements for hazardous waste.	These regulations applied to the management of any waste from the soil remedy that was determined to be hazardous.



**ATTACHMENT A  
TABLE 3**

**FEDERAL AND STATE ACTION-SPECIFIC ARARs AND TBCs – DRUM REMOVAL AND OFF-SITE DISPOSAL  
CED AREA DRUM REMOVAL - ACTION MEMORANDUM  
NCBC DAVISVILLE  
NORTH KINGSTOWN, RHODE ISLAND  
PAGE 2 OF 2**

State				
Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Clean Air Act - Fugitive Dust Control	Air Pollution Control Regulation No. 5 – Fugitive Dust	Applicable	Requires that reasonable precaution be taken to prevent particulate matter from becoming airborne.	Control of dust during excavation and handling of soil was implemented to prevent material from becoming airborne. All contaminated soil that would pose a risk from fugitive dust was removed and disposed of off-site.

WE04 Davisville  
Site 3 Summary of Analytical Results

SAMPLE ID				DRUM-01-SOIL		DRUM-05-SOIL		DRUM-06-SOIL		DRUM-07-SOIL		DRUM-99-SOIL (FD)		DRUM-08-SOIL		DRUM-09-SOIL		DRUM-10-SOIL		DRUM-11-SOIL		DRUM-12-SOIL	
SAMPLE DATE				10/24/2013		10/22/2013		10/24/2013		10/24/2013		10/24/2013		10/24/2013		10/24/2013		10/24/2013		10/24/2013		10/24/2013	
MATRIX				SOIL		SOIL		SOIL		SOIL		SOIL		SOIL		SOIL		SOIL		SOIL		SOIL	
TCL VOCs by 8260C	PROJECT ACTION LIMITS <sup>a</sup>		UNITS																				
1,1,1-Trichloroethane	RIDEM RDEC	540,000	UG/KG	0.49	U	0.56	U	0.49	U	0.56	U	0.61	U	0.5	U	0.54	U	0.59	U	0.57	U	0.49	U
1,1,1,2-Tetrachloroethane <sup>b</sup>	EPA RSL	1,900	UG/KG	0.49	U	0.56	U	0.49	U	0.56	U	0.61	U	0.5	U	0.54	U	0.59	U	0.57	U	0.49	U
1,1,2,2-Tetrachloroethane	EPA RSL	560	UG/KG	0.49	U	0.56	U	0.49	U	0.56	U	0.61	U	0.5	U	0.54	U	0.59	U	0.57	U	0.49	U
1,1,2-Trichloroethane	EPA RSL	160	UG/KG	0.98	U	1.1	U	0.98	U	1.1	U	1.2	U	0.99	U	1.1	U	1.2	U	1.1	U	0.98	U
1,1,2-Trichlorotrifluoroethane ***	EPA RSL	4,300,000	UG/KG	0.49	UQ	0.56	U	0.49	UQ	0.56	UQ	0.61	UQ	0.5	UQ	0.54	UQ	0.59	UQ	0.57	UQ	0.49	UQ
1,1-Dichloroethane	EPA RSL	3,300	UG/KG	0.49	U	0.56	U	0.49	U	0.56	U	0.61	U	0.5	U	0.54	U	0.59	U	0.57	U	0.49	U
1,1-Dichloroethene	RIDEM RDEC	200	UG/KG	0.49	UQ	0.56	U	0.49	UQ	0.56	UQ	0.61	UQ	0.5	UQ	0.54	UQ	0.59	UQ	0.57	UQ	0.49	UQ
1,2-Dibromoethane	RIDEM RDEC	10	UG/KG	0.49	U	0.56	U	0.49	U	0.56	U	0.61	U	0.5	U	0.54	U	0.59	U	0.57	U	0.49	U
1,2-Dibromo-3-Chloropropane	EPA RSL	5.4	UG/KG	4.9	U	5.6	U	4.9	U	5.6	U	6.1	U	5	U	5.4	U	5.9	U	5.7	U	4.9	U
1,2-Dichlorobenzene	EPA RSL	190,000	UG/KG	0.49	U	0.56	U	0.49	U	0.56	U	0.61	U	0.5	U	0.54	U	0.59	U	0.57	U	0.49	U
1,2-Dichloroethane	EPA RSL	430	UG/KG	0.49	U	0.56	U	0.49	U	0.56	U	0.61	U	0.5	U	0.54	U	0.59	U	0.57	U	0.49	U
1,2-Dichloropropane	EPA RSL	940	UG/KG	0.49	UQ	0.56	U	0.49	UQ	0.56	UQ	0.61	UQ	0.5	UQ	0.54	UQ	0.59	UQ	0.57	UQ	0.49	UQ
1,2,3-Trichlorobenzene	EPA RSL	4,900	UG/KG	0.98	U	1.1	U	0.98	U	1.1	U	1.2	U	0.99	U	1.1	U	1.2	U	1.1	U	0.98	U
1,2,4-Trichlorobenzene	EPA RSL	6,200	UG/KG	0.49	U	0.56	U	0.49	U	0.56	U	0.61	U	0.5	U	0.54	U	0.59	U	0.57	U	0.49	U
1,3-Dichlorobenzene	RIDEM RDEC	430,000	UG/KG	0.49	U	0.56	U	0.49	U	0.56	U	0.61	U	0.5	U	0.54	U	0.59	U	0.57	U	0.49	U
1,4-Dichlorobenzene	EPA RSL	2,400	UG/KG	0.49	U	0.56	U	0.49	U	0.56	U	0.61	U	0.5	U	0.54	U	0.59	U	0.57	U	0.49	U
1,4-Dioxane	EPA RSL	4,900	UG/KG	97.6	U	110	U	97.6	U	110	U	120	U	99.2	U	110	U	120	U	110	U	97.6	U
2-Butanone	EPA RSL	2,800,000	UG/KG	7.3	U	8.3	U	7.3	U	8.4	U	9.1	U	7.4	U	8.1	U	8.9	U	8.5	U	7.3	U
2-Hexanone	EPA RSL	21,000	UG/KG	2.4	U	2.8	U	2.4	U	2.8	U	3	U	2.5	U	2.7	U	3	U	2.8	U	2.4	U
4-Methyl-2-Pentanone	EPA RSL	530,000	UG/KG	2.4	U	2.8	U	2.4	U	2.8	U	3	U	2.5	U	2.7	U	3	U	2.8	U	2.4	U
Acetone	EPA RSL	6,100,000	UG/KG	2.4	U	2.8	U	2.4	U	2.8	U	3	U	9.3	J	2.7	U	3	U	2.8	U	2.4	U
Benzene	EPA RSL	1,100	UG/KG	0.49	U	0.56	U	0.49	U	0.56	U	0.61	U	0.5	U	0.54	U	0.59	U	0.57	U	0.49	U
Bromochloromethane	RIDEM RDEC	10,000	UG/KG	0.49	U	0.56	U	0.49	U	0.56	U	0.61	U	0.5	U	0.54	U	0.59	U	0.57	U	0.49	U
Bromodichloromethane	EPA RSL	270	UG/KG	0.49	U	0.56	U	0.49	U	0.56	U	0.61	U	0.5	U	0.54	U	0.59	U	0.57	U	0.49	U
Bromoform	EPA RSL	62,000	UG/KG	1.5	U	1.7	U	1.5	U	1.7	U	1.8	U	1.5	U	1.6	U	1.8	U	1.7	U	1.5	U
Bromomethane	EPA RSL	730	UG/KG	0.98	U	1.1	U	0.98	U	1.1	U	1.2	U	0.99	U	1.1	U	1.2	U	1.1	U	0.98	U
Carbon Disulfide	EPA RSL	82,000	UG/KG	0.49	U	0.56	U	0.49	U	0.56	U	0.61	U	0.5	U	0.54	U	0.59	U	0.57	U	0.49	U
Carbon Tetrachloride	EPA RSL	610	UG/KG	0.49	U	0.56	U	0.49	U	0.56	U	0.61	U	0.5	U	0.54	U	0.59	U	0.57	U	0.49	U
Chlorobenzene	EPA RSL	29,000	UG/KG	0.49	U	0.56	U	0.49	U	0.56	U	0.61	U	0.5	U	0.54	U	0.59	U	0.57	U	0.49	U
Chloroethane	EPA RSL	1,500,000	UG/KG	0.49	U	0.56	U	0.49	U	0.56	U	0.61	U	0.5	U	0.54	U	0.59	U	0.57	U	0.49	U
Chloroform	EPA RSL	290	UG/KG	0.49	U	0.56	U	0.49	U	0.56	U	0.61	U	0.5	U	0.54	U	0.59	U	0.57	U	0.49	U
Chloromethane	EPA RSL	12,000	UG/KG	0.49	U	0.56	U	0.49	U	0.56	U	0.61	U	0.5	U	0.54	U	0.59	U	0.57	U	0.49	U
cis-1,2-Dichloroethene	EPA RSL	16,000	UG/KG	0.49	U	0.56	U	0.49	U	0.56	U	0.61	U	0.5	U	0.54	U	0.59	U	10.3		14.4	
cis-1,3-Dichloropropene	EPA RSL	1,700 <sup>c</sup>	UG/KG	0.49	U	0.56	U	0.49	U	0.56	U	0.61	U	0.5	U	0.54	U	0.59	U	0.57	U	0.49	U
Cyclohexane	EPA RSL	700,000	UG/KG	0.49	U	0.56	U	0.49	U	0.56	U	0.61	U	0.5	U	0.54	U	0.59	U	0.57	U	0.49	U
Dibromochloromethane	EPA RSL	680	UG/KG	0.49	U	0.56	U	0.49	U	0.56	U	0.61	U	0.5	U	0.54	U	0.59	U	0.57	U	0.49	U

WE04 Davisville  
Site 3 Summary of Analytical Results

SAMPLE ID				DRUM-01-SOIL		DRUM-05-SOIL		DRUM-06-SOIL		DRUM-07-SOIL		DRUM-99-SOIL (FD)		DRUM-08-SOIL		DRUM-09-SOIL		DRUM-10-SOIL		DRUM-11-SOIL		DRUM-12-SOIL	
SAMPLE DATE				10/24/2013		10/22/2013		10/24/2013		10/24/2013		10/24/2013		10/24/2013		10/24/2013		10/24/2013		10/24/2013		10/24/2013	
MATRIX				SOIL		SOIL		SOIL		SOIL		SOIL		SOIL		SOIL		SOIL		SOIL		SOIL	
TCL VOCs by 8260C		PROJECT ACTION LIMITS <sup>a</sup>		UNITS																			
Dichlorodifluoromethane	EPA RSL	9,400	UG/KG	0.49	UQ	0.56	U	0.49	UQ	0.56	UQ	0.61	UQ	0.5	UQ	0.54	UQ	0.59	UQ	0.57	UQ	0.49	UQ
Ethyl Benzene	EPA RSL	5,400	UG/KG	0.49	U	0.56	U	0.49	U	0.56	U	0.61	U	0.5	U	0.54	U	0.59	U	0.57	U	0.49	U
Isopropylbenzene	RIDEM RDEC	27,000	UG/KG	0.49	U	0.56	U	0.49	U	0.56	U	0.61	U	0.5	U	0.54	U	0.59	U	0.57	U	0.49	U
Methyl Acetate	EPA RSL	7,800,000	UG/KG	0.98	U	1.1	U	0.98	U	1.1	U	1.2	U	0.99	U	1.1	U	1.2	U	1.1	U	0.98	U
Methyl tert-butyl Ether	EPA RSL	43,000	UG/KG	0.49	U	0.56	U	0.49	U	0.56	U	0.61	U	0.5	U	0.54	U	0.59	U	0.57	U	0.49	U
Methylene Chloride	EPA RSL	36,000	UG/KG	2.4	JB	0.56	U	2.7	JQB	2.9	JQB	3.7	JQB	2.5	JQB	2.7	JQB	3.3	JQB	3.1	JQB	2.9	JQB
Styrene	RIDEM RDEC	13,000	UG/KG	0.49	U	0.56	U	0.49	U	0.56	U	0.61	U	0.5	U	0.54	U	0.59	U	0.57	U	0.49	U
Tetrachloroethene	EPA RSL	8,600	UG/KG	0.49	U	0.56	U	0.49	U	0.56	U	0.61	U	0.5	U	0.54	U	0.59	U	0.57	U	0.49	U
Toluene	RIDEM RDEC	190,000	UG/KG	0.49	U	0.56	U	0.49	U	0.56	U	0.61	U	0.5	U	0.54	U	0.59	U	0.57	U	0.49	U
trans-1,2-Dichloroethene	EPA RSL	15,000	UG/KG	0.49	U	0.56	U	0.49	U	0.56	U	0.61	U	0.5	U	0.54	U	0.59	U	0.57	U	0.49	U
trans-1,3-Dichloropropene	EPA RSL	1,700 <sup>c</sup>	UG/KG	0.49	U	0.56	U	0.49	U	0.56	U	0.61	U	0.5	U	0.54	U	0.59	U	0.57	U	0.49	U
Trichloroethene	EPA RSL	440	UG/KG	0.49	U	0.56	U	0.49	U	0.56	U	0.61	U	0.5	U	0.54	U	0.59	U	4.4	J	7	
Trichlorofluoromethane	EPA RSL	79,000	UG/KG	0.49	U	0.56	U	0.49	U	0.56	U	0.61	U	0.5	U	0.54	U	0.59	U	0.57	U	0.49	U
Vinyl Chloride	RIDEM RDEC	20	UG/KG	0.49	U	0.56	U	0.49	U	0.56	U	0.61	U	0.5	U	0.54	U	0.59	U	0.57	U	0.49	U
Xylenes, total	EPA RSL	63,000	UG/KG	1.47	U	1.66	U	1.47	U	1.66	U	1.81	U	1.49	U	1.64	U	1.79	U	1.67	U	1.47	U
TCL SVOCs by 8270D																							
1,1-Biphenyl	RIDEM RDEC	800	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
1,2,4,5-Tetrachlorobenzene	EPA RSL	1,800	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
2,2-oxybis(1-Chloropropane) ****	EPA RSL	4,600	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
2,3,4,6-Tetrachlorophenol	EPA RSL	180,000	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
2,4,5-Trichlorophenol	RIDEM RDEC	330,000	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
2,4,6-Trichlorophenol	EPA RSL	6,100	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
2,4-Dichlorophenol	EPA RSL	18,000	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
2,4-Dimethylphenol	EPA RSL	120,000	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
2,4-Dinitrophenol	EPA RSL	12,000	UG/KG	300	U	290	U	290	U	280	U	290	U	290	U	290	U	280	U	290	U	290	U
2,4-Dinitrotoluene	RIDEM RDEC	900	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
2,6-Dinitrotoluene	EPA RSL	330	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
2-Chloronaphthalene	EPA RSL	630,000	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
2-Chlorophenol	EPA RSL	39,000	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
2-Methylnaphthalene	EPA RSL	23,000	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
2-Methylphenol	EPA RSL	310,000	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
2-Nitroaniline	EPA RSL	61,000	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
3,3-Dichlorobenzidine	EPA RSL	1,100	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
3+4-Methylphenols	EPA RSL	610,000	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
4,6-Dinitro-2-methylphenol	EPA RSL	490	UG/KG	180	U	180	U	180	U	180	U	180	U	180	U	180	U	180	U	180	U	180	U
4-Chloro-3-methylphenol	EPA RSL	610,000	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U

WE04 Davisville  
Site 3 Summary of Analytical Results

SAMPLE ID				DRUM-01-SOIL		DRUM-05-SOIL		DRUM-06-SOIL		DRUM-07-SOIL		DRUM-99-SOIL (FD)		DRUM-08-SOIL		DRUM-09-SOIL		DRUM-10-SOIL		DRUM-11-SOIL		DRUM-12-SOIL	
SAMPLE DATE				10/24/2013		10/22/2013		10/24/2013		10/24/2013		10/24/2013		10/24/2013		10/24/2013		10/24/2013		10/24/2013		10/24/2013	
MATRIX				SOIL		SOIL		SOIL		SOIL		SOIL		SOIL		SOIL		SOIL		SOIL		SOIL	
TCL VOCs by 8260C	PROJECT ACTION LIMITS <sup>a</sup>		UNITS																				
4-Chloroaniline	EPA RSL	2,400	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
4-Nitroaniline	EPA RSL	24,000	UG/KG	74	U	71.9	U	71.4	U	70.8	U	71.3	U	71.8	U	72.5	U	70.9	U	72.8	U	72.3	U
Acenaphthene	RIDEM RDEC	43,000	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
Acenaphthylene	RIDEM RDEC	23,000	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
Acetophenone	EPA RSL	780,000	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
Anthracene	RIDEM RDEC	35,000	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
Atrazine	EPA RSL	2,100	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
Benzaldehyde	EPA RSL	780,000	UG/KG	37	UQ	35.9	U	35.7	UQ	35.4	UQ	35.6	UQ	35.9	UQ	36.2	UQ	35.4	UQ	36.4	UQ	36.1	UQ
Benzo(a)anthracene	EPA RSL	150 *	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
Benzo(a)pyrene	EPA RSL	15 *	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
Benzo(b)fluoranthene	EPA RSL	150 *	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
Benzo(g,h,i)perylene	RIDEM RDEC	800	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
Benzo(k)fluoranthene	RIDEM RDEC	900	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
bis(2-Chloroethoxy)methane	EPA RSL	18,000	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
bis(2-Chloroethyl)ether	EPA RSL	210 *	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
Bis(2-ethylhexyl)phthalate	EPA RSL	35,000	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
Butylbenzylphthalate	EPA RSL	260,000	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
Caprolactam	EPA RSL	3,100,000	UG/KG	74	U	71.9	U	71.4	U	70.8	U	71.3	U	71.8	U	72.5	U	70.9	U	72.8	U	72.3	U
Chrysene	RIDEM RDEC	400	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
Dibenzo(a,h)anthracene	EPA RSL	15 *	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
Dibenzofuran	EPA RSL	7,800	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
Diethylphthalate	RIDEM RDEC	340,000	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	140	J	36.1	U
Dimethylphthalate	RIDEM RDEC	1,900,000	UG/KG	420		440		360		640		770		680		220	J	450		450		430	
Di-n-butylphthalate	EPA RSL	610,000	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
Di-n-octyl phthalate	EPA RSL	61,000	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
Fluoranthene	RIDEM RDEC	20,000	UG/KG	83.9	J	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	74.7	J	36.4	U	36.1	U
Fluorene	RIDEM RDEC	28,000	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
Hexachlorobenzene	EPA RSL	300 *	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
Hexachlorobutadiene	EPA RSL	6,100	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
Hexachlorocyclopentadiene	EPA RSL	37,000	UG/KG	37	UQ	35.9	UQ	35.7	UQ	35.4	UQ	35.6	UQ	35.9	UQ	36.2	UQ	35.4	UQ	36.4	UQ	36.1	UQ
Hexachloroethane	EPA RSL	4,300	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
Indeno(1,2,3-cd)pyrene	EPA RSL	150 *	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
Isophorone	EPA RSL	510,000	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
Naphthalene	EPA RSL	3,600	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
Nitrobenzene	EPA RSL	4,800	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
n-Nitroso-di-n-propylamine	EPA RSL	69 *	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U

WE04 Davisville  
Site 3 Summary of Analytical Results

SAMPLE ID				DRUM-01-SOIL		DRUM-05-SOIL		DRUM-06-SOIL		DRUM-07-SOIL		DRUM-99-SOIL (FD)		DRUM-08-SOIL		DRUM-09-SOIL		DRUM-10-SOIL		DRUM-11-SOIL		DRUM-12-SOIL	
SAMPLE DATE				10/24/2013		10/22/2013		10/24/2013		10/24/2013		10/24/2013		10/24/2013		10/24/2013		10/24/2013		10/24/2013		10/24/2013	
MATRIX				SOIL		SOIL		SOIL		SOIL		SOIL		SOIL		SOIL		SOIL		SOIL		SOIL	
TCL VOCs by 8260C		PROJECT ACTION LIMITS <sup>a</sup>		UNITS																			
n-Nitrosodiphenylamine	EPA RSL	99,000	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
Pentachlorophenol	EPA RSL	890	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
Phenanthrene	RIDEM RDEC	40,000	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
Phenol	EPA RSL	1,800,000	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
Pyrene	RIDEM RDEC	13,000	UG/KG	37	U	35.9	U	35.7	U	35.4	U	35.6	U	35.9	U	36.2	U	35.4	U	36.4	U	36.1	U
TCL Pesticides by 8081B																							
4,4-DDD	EPA RSL	2,000	UG/KG	0.366	U	0.355	U	0.354	U	0.351	U	0.353	U	0.355	U	0.359	U	0.35	U	0.36	U	0.357	U
4,4-DDE	EPA RSL	1,400	UG/KG	0.366	U	0.355	U	0.354	U	0.351	U	0.353	U	0.355	U	0.359	U	0.35	U	0.36	U	0.357	U
4,4-DDT	EPA RSL	1,700	UG/KG	0.366	U	0.355	U	0.354	U	0.351	U	0.353	U	0.355	U	0.359	U	0.35	U	0.36	U	0.357	U
alpha-BHC	EPA RSL	77	UG/KG	0.366	U	0.355	U	0.354	U	0.351	U	0.353	U	0.355	U	0.359	U	0.35	U	0.36	U	0.357	U
Aldrin	EPA RSL	29	UG/KG	0.366	U	0.355	U	0.354	U	0.351	U	0.353	U	0.355	U	0.359	U	0.35	U	0.36	U	0.357	U
beta-BHC	EPA RSL	270	UG/KG	0.366	U	0.355	U	0.354	U	0.351	U	0.353	U	0.355	U	0.359	U	0.35	U	0.36	U	0.357	U
Chlordane, technical	RIDEM RDEC	500	UG/KG	3.7	U	3.6	U	3.6	U	3.5	U	3.6	U	3.6	U	3.6	U	3.5	U	3.6	U	3.6	U
Dieldrin	EPA RSL	30	UG/KG	0.366	U	0.355	U	0.354	U	0.351	U	0.353	U	0.355	U	0.359	U	0.35	U	0.36	U	0.357	U
Endosulfan I	EPA RSL	37,000 <sup>d</sup>	UG/KG	0.366	U	0.355	U	0.354	U	0.351	U	0.353	U	0.355	U	0.359	U	0.35	U	0.36	U	0.357	U
Endosulfan II	EPA RSL	37,000 <sup>d</sup>	UG/KG	0.366	U	0.355	U	0.354	U	0.351	U	0.353	U	0.355	U	0.359	U	0.35	U	0.36	U	0.357	U
Endrin	EPA RSL	1,800	UG/KG	0.366	U	0.355	U	0.354	U	0.351	U	0.353	U	0.355	U	0.359	U	0.35	U	0.36	U	0.357	U
gamma-BHC (Lindane)	EPA RSL	520	UG/KG	0.366	U	0.355	U	0.354	U	0.351	U	0.353	U	0.355	U	0.359	U	0.35	U	0.36	U	0.357	U
Heptachlor	EPA RSL	110	UG/KG	0.366	U	0.355	U	0.354	U	0.351	U	0.353	U	0.355	U	0.359	U	0.35	U	0.36	U	0.357	U
Heptachlor epoxide	EPA RSL	53	UG/KG	0.366	U	0.355	U	0.354	U	0.351	U	0.353	U	0.355	U	0.359	U	0.35	U	0.36	U	0.357	U
Methoxychlor	EPA RSL	31,000	UG/KG	0.366	U	0.355	U	0.354	U	0.351	U	0.353	U	0.355	U	0.359	U	0.35	U	0.36	U	0.357	U
Toxaphene	EPA RSL	440	UG/KG	3.7	U	3.6	U	3.6	U	3.5	U	3.6	U	3.6	U	3.6	U	3.5	U	3.6	U	3.6	U
TCL PCBs by 8082A																							
Aroclor-1016	EPA RSL	390	UG/KG	3.7	U	3.6	U	3.6	U	3.5	U	3.6	U	3.6	U	3.6	U	3.5	U	3.6	U	3.6	U
Aroclor-1221	EPA RSL	140	UG/KG	3.7	U	3.6	U	3.6	U	3.5	U	3.6	U	3.6	U	3.6	U	3.5	U	3.6	U	3.6	U
Aroclor-1232	EPA RSL	140	UG/KG	3.7	U	3.6	U	3.6	U	3.5	U	3.6	U	3.6	U	3.6	U	3.5	U	3.6	U	3.6	U
Aroclor-1242	EPA RSL	220	UG/KG	3.7	U	3.6	U	3.6	U	3.5	U	3.6	U	3.6	U	3.6	U	3.5	U	3.6	U	3.6	U
Aroclor-1248	EPA RSL	220	UG/KG	3.7	U	3.6	U	3.6	U	3.5	U	3.6	U	3.6	U	3.6	U	3.5	U	3.6	U	3.6	U
Aroclor-1254	EPA RSL	110	UG/KG	3.7	U	3.6	U	3.6	U	3.5	U	3.6	U	3.6	U	3.6	U	3.5	U	3.6	U	3.6	U
Aroclor-1260	EPA RSL	220	UG/KG	53.1	P	23.2	P	22.6		49.1		72.2		20.2		17.3	J	38.6		45		26.7	P
TAL Metals and Mercury by 6010C/7471B																							
Aluminum	EPA RSL	7,700	MG/KG	1,400	DN	6,900	DN	7,400	DN	1,400	DN	1,400	DN	1,100	DN	1,200	DN	1,200	DN	8,900	DN	1,400	DN
Antimony	EPA RSL	3.1	MG/KG	1.2	UN	1.13	UN	1.16	UN	1.09	UN	1.12	UN	1.14	UN	0.778	JN	1.14	UN	1.15	UN	1.11	UN
Arsenic	EPA RSL	0.61 *	MG/KG	2.14		1.46		1.91		2.28		2.2		1.84		5.62		1.8		1.97		2.06	
Barium	EPA RSL	1,500	MG/KG	16.8		15.1		16.9		14.6		14.3		12.4		16.1		13.5		16.6		12.5	
Beryllium	RIDEM RDEC	1.5	MG/KG	0.294		0.281		0.339		0.281		0.323		0.241	J	0.182	J	0.306		0.384		0.311	

WE04 Davisville  
Site 3 Summary of Analytical Results

SAMPLE ID				DRUM-01-SOIL		DRUM-05-SOIL		DRUM-06-SOIL		DRUM-07-SOIL		DRUM-99-SOIL (FD)		DRUM-08-SOIL		DRUM-09-SOIL		DRUM-10-SOIL		DRUM-11-SOIL		DRUM-12-SOIL	
SAMPLE DATE				10/24/2013		10/22/2013		10/24/2013		10/24/2013		10/24/2013		10/24/2013		10/24/2013		10/24/2013		10/24/2013		10/24/2013	
MATRIX				SOIL		SOIL		SOIL		SOIL		SOIL		SOIL		SOIL		SOIL		SOIL		SOIL	
TCL VOCs by 8260C		PROJECT ACTION LIMITS <sup>a</sup>		UNITS																			
Cadmium	EPA RSL	7	MG/KG	0.144	U	0.143	J	0.139	U	0.13	U	0.134	U	0.137	U	0.138	U	0.136	U	0.133	J	0.133	U
Chromium <sup>e</sup>	RIDEM RDEC	1,400	MG/KG	7.76		17.9		6.31		24.9		9.35		6.23		8.55		6.37		8.5		7.81	
Cobalt	EPA RSL	2.3	MG/KG	5.57		4.71		4.6		5.53		5.77		6.32		5.63		4.93		6.26		5.11	
Copper	EPA RSL	310	MG/KG	9.25		5.87		7.54		9.36		11.8		8.22		9.45		6.94		8.8		8.36	
Iron	EPA RSL	5,500	MG/KG	2,700	DN	22,200	DN	13,200	DN	3,700	DN	3,700	DN	3,500	DN	33,400	DN	2,700	DN	14,100	DN	2,700	DN
Lead	RIDEM RDEC	150	MG/KG	37		97.4		39.6		128		47.3		22.8		34.8		31.7		36.3		31.6	
Manganese	EPA RSL	180	MG/KG	122		124		114		131		135		156		172		104		147		118	
Mercury	EPA RSL	1	MG/KG	0.012		0.012		0.013		0.014		0.015		0.013		0.012		0.008	J	0.013		0.012	
Nickel	EPA RSL	150	MG/KG	10.1		7.95		7.49		9.63		10.92		8.52		9.63		7.47		9.71		8.15	
Selenium	EPA RSL	39	MG/KG	0.463	J	0.454	U	0.465	U	0.552	J	0.536	J	0.457	U	0.623	J	0.411	J	0.459	U	0.44	J
Silver	EPA RSL	39	MG/KG	0.896		1.48		0.808		1.19		1.23		1.18		2.13		0.864		0.9		0.837	
Thallium	EPA RSL	0.078 **	MG/KG	0.962	U	0.907	U	0.93	U	0.869	U	0.896	U	0.913	U	0.919	U	0.909	U	0.918	U	0.89	U
Vanadium	EPA RSL	39	MG/KG	13.3		11.5		11.6		12.8		12.7		10.97		12.7		10.87		14.4		11.7	
Zinc	EPA RSL	2,300	MG/KG	44.8		43		44.9		49.4		54.7		36.9		50.4		45.9		42.3		47.9	
Cyanide by 9012B																							
Cyanide	EPA RSL	2.2	MG/KG	0.037	J	0.068	J	0.134	U	0.133	U	0.036	J	0.069	J	0.068	J	0.133	U	0.137	U	0.136	U
Total Petroleum Hydrocarbons by 8015B																							
Petroleum hydrocarbons <sup>f</sup>	RIDEM RDEC	500	MG/KG	11.554		7.45		21.736		8.236		14.477		10.853		106.263		9.488		33.757		20.532	

WE04 Davisville  
Site 3 Summary of Analytical Results

SAMPLE ID				TP-01-PIPE		TP-02-PIPE		TP-03-PIPE		TP-04-SOIL		TP-05-SOIL		TP-06-SOIL		TP-07-SOIL		TP-08-SOIL		TP-09-SOIL	
SAMPLE DATE				10/25/2013		10/25/2013		10/25/2013		10/25/2013		10/25/2013		10/25/2013		10/25/2013		10/25/2013		10/25/2013	
MATRIX				SOIL		SOIL		SOIL		SOIL		SOIL		SOIL		SOIL		SOIL		SOIL	
TCL VOCs by 8260C	PROJECT ACTION LIMITS <sup>a</sup>		UNITS																		
1,1,1-Trichloroethane	RIDEM RDEC	540,000	UG/KG	0.52	U	0.51	U	0.49	U	0.46	U	0.46	U	0.52	U	0.42	U	0.6	U	0.65	U
1,1,1,2-Tetrachloroethane <sup>b</sup>	EPA RSL	1,900	UG/KG	0.52	U	0.51	U	0.49	U	0.46	U	0.46	U	0.52	U	0.42	U	0.6	U	0.65	U
1,1,2,2-Tetrachloroethane	EPA RSL	560	UG/KG	0.52	U	0.51	U	0.49	U	0.46	U	0.46	U	0.52	U	0.42	U	0.6	U	0.65	U
1,1,2-Trichloroethane	EPA RSL	160	UG/KG	1	U	1	U	0.98	U	0.91	U	0.91	U	1	U	0.84	U	1.2	U	1.3	U
1,1,2-Trichlorotrifluoroethane ***	EPA RSL	4,300,000	UG/KG	0.52	U	0.51	U	0.49	U	0.46	U	0.46	U	0.52	U	0.42	U	0.6	U	0.65	U
1,1-Dichloroethane	EPA RSL	3,300	UG/KG	0.52	U	0.51	U	0.49	U	0.46	U	0.46	U	0.52	U	0.42	U	0.6	U	0.65	U
1,1-Dichloroethene	RIDEM RDEC	200	UG/KG	0.52	U	0.51	U	0.49	U	0.46	U	0.46	U	0.52	U	0.42	U	0.6	U	0.65	U
1,2-Dibromoethane	RIDEM RDEC	10	UG/KG	0.52	U	0.51	U	0.49	U	0.46	U	0.46	U	0.52	U	0.42	U	0.6	U	0.65	U
1,2-Dibromo-3-Chloropropane	EPA RSL	5.4	UG/KG	5.2	U	5.1	U	4.9	U	4.6	U	4.6	U	5.2	U	4.2	U	6	U	6.5	U
1,2-Dichlorobenzene	EPA RSL	190,000	UG/KG	0.52	U	0.51	U	0.49	U	0.46	U	0.46	U	0.52	U	0.42	U	0.6	U	0.65	U
1,2-Dichloroethane	EPA RSL	430	UG/KG	0.52	U	0.51	U	0.49	U	0.46	U	0.46	U	0.52	U	0.42	U	0.6	U	0.65	U
1,2-Dichloropropane	EPA RSL	940	UG/KG	0.52	U	0.51	U	0.49	U	0.46	U	0.46	U	0.52	U	0.42	U	0.6	U	0.65	U
1,2,3-Trichlorobenzene	EPA RSL	4,900	UG/KG	1	U	1	U	0.98	U	0.91	U	0.91	U	1	U	0.84	U	1.2	U	1.3	U
1,2,4-Trichlorobenzene	EPA RSL	6,200	UG/KG	0.52	U	0.51	U	0.49	U	0.46	U	0.46	U	0.52	U	0.42	U	0.6	U	0.65	U
1,3-Dichlorobenzene	RIDEM RDEC	430,000	UG/KG	0.52	U	0.51	U	0.49	U	0.46	U	0.46	U	0.52	U	0.42	U	0.6	U	0.65	U
1,4-Dichlorobenzene	EPA RSL	2,400	UG/KG	0.52	U	0.51	U	0.49	U	0.46	U	0.46	U	0.52	U	0.42	U	0.6	U	0.65	U
1,4-Dioxane	EPA RSL	4,900	UG/KG	100	U	100	U	97.5	U	91.5	U	91.1	U	100	U	84	U	120	U	130	U
2-Butanone	EPA RSL	2,800,000	UG/KG	7.9	U	7.6	U	7.3	U	6.9	U	6.8	U	7.8	U	6.3	U	9	U	9.8	U
2-Hexanone	EPA RSL	21,000	UG/KG	2.6	U	2.5	U	2.4	U	2.3	U	2.3	U	2.6	U	2.1	U	3	U	3.3	U
4-Methyl-2-Pentanone	EPA RSL	530,000	UG/KG	2.6	U	2.5	U	2.4	U	2.3	U	2.3	U	2.6	U	2.1	U	3	U	3.3	U
Acetone	EPA RSL	6,100,000	UG/KG	2.6	U	2.5	U	2.4	U	2.3	U	2.3	U	2.6	U	2.1	U	3	U	3.3	U
Benzene	EPA RSL	1,100	UG/KG	0.52	U	0.51	U	0.49	U	0.46	U	0.46	U	0.52	U	0.42	U	0.6	U	0.65	U
Bromochloromethane	RIDEM RDEC	10,000	UG/KG	0.52	U	0.51	U	0.49	U	0.46	U	0.46	U	0.52	U	0.42	U	0.6	U	0.65	U
Bromodichloromethane	EPA RSL	270	UG/KG	0.52	U	0.51	U	0.49	U	0.46	U	0.46	U	0.52	U	0.42	U	0.6	U	0.65	U
Bromoform	EPA RSL	62,000	UG/KG	1.6	U	1.5	U	1.5	U	1.4	U	1.4	U	1.6	U	1.3	U	1.8	U	2	U
Bromomethane	EPA RSL	730	UG/KG	1	U	1	U	0.98	U	0.91	U	0.91	U	1	U	0.84	U	1.2	U	1.3	U
Carbon Disulfide	EPA RSL	82,000	UG/KG	0.52	U	0.51	U	0.49	U	0.46	U	0.46	U	0.52	U	0.42	U	0.6	U	0.65	U
Carbon Tetrachloride	EPA RSL	610	UG/KG	0.52	U	0.51	U	0.49	U	0.46	U	0.46	U	0.52	U	0.42	U	0.6	U	0.65	U
Chlorobenzene	EPA RSL	29,000	UG/KG	0.52	U	0.51	U	0.49	U	0.46	U	0.46	U	0.52	U	0.42	U	0.6	U	0.65	U
Chloroethane	EPA RSL	1,500,000	UG/KG	0.52	U	0.51	U	0.49	U	0.46	U	0.46	U	0.52	U	0.42	U	0.6	U	0.65	U
Chloroform	EPA RSL	290	UG/KG	0.52	U	0.51	U	0.49	U	0.46	U	0.46	U	0.52	U	0.42	U	0.6	U	0.65	U
Chloromethane	EPA RSL	12,000	UG/KG	0.52	U	0.51	U	0.49	U	0.46	U	0.46	U	0.52	U	0.42	U	0.6	U	0.65	U
cis-1,2-Dichloroethene	EPA RSL	16,000	UG/KG	0.52	U	0.51	U	0.49	U	0.46	U	0.46	U	0.52	U	0.42	U	0.6	U	0.65	U
cis-1,3-Dichloropropene	EPA RSL	1,700 <sup>c</sup>	UG/KG	0.52	U	0.51	U	0.49	U	0.46	U	0.46	U	0.52	U	0.42	U	0.6	U	0.65	U
Cyclohexane	EPA RSL	700,000	UG/KG	0.52	U	0.51	U	0.49	U	0.46	U	0.46	U	0.52	U	0.42	U	0.6	U	0.65	U
Dibromochloromethane	EPA RSL	680	UG/KG	0.52	U	0.51	U	0.49	U	0.46	U	0.46	U	0.52	U	0.42	U	0.6	U	0.65	U



WE04 Davisville  
Site 3 Summary of Analytical Results

SAMPLE ID				TP-01-PIPE		TP-02-PIPE		TP-03-PIPE		TP-04-SOIL		TP-05-SOIL		TP-06-SOIL		TP-07-SOIL		TP-08-SOIL		TP-09-SOIL	
SAMPLE DATE				10/25/2013		10/25/2013		10/25/2013		10/25/2013		10/25/2013		10/25/2013		10/25/2013		10/25/2013		10/25/2013	
MATRIX				SOIL		SOIL		SOIL		SOIL		SOIL		SOIL		SOIL		SOIL		SOIL	
TCL VOCs by 8260C	PROJECT ACTION LIMITS <sup>a</sup>		UNITS																		
Dichlorodifluoromethane	EPA RSL	9,400	UG/KG	0.52	U	0.51	U	0.49	U	0.46	U	0.46	U	0.52	U	0.42	U	0.6	U	0.65	U
Ethyl Benzene	EPA RSL	5,400	UG/KG	0.52	U	0.51	U	0.49	U	0.46	U	0.46	U	0.52	U	0.42	U	0.6	U	0.65	U
Isopropylbenzene	RIDEM RDEC	27,000	UG/KG	0.52	U	0.51	U	0.49	U	0.46	U	0.46	U	0.52	U	0.42	U	0.6	U	0.65	U
Methyl Acetate	EPA RSL	7,800,000	UG/KG	1	U	1	U	0.98	U	0.91	U	0.91	U	1	U	0.84	U	1.2	U	1.3	U
Methyl tert-butyl Ether	EPA RSL	43,000	UG/KG	0.52	U	0.51	U	0.49	U	0.46	U	0.46	U	0.52	U	0.42	U	0.6	U	0.65	U
Methylene Chloride	EPA RSL	36,000	UG/KG	2.3	JB	2.4	JB	2	JB	1.9	JB	1.5	JB	1.1	JB	1	JB	1.4	JB	0.65	U
Styrene	RIDEM RDEC	13,000	UG/KG	0.52	U	0.51	U	0.49	U	0.46	U	0.46	U	0.52	U	0.42	U	0.6	U	0.65	U
Tetrachloroethene	EPA RSL	8,600	UG/KG	0.52	U	0.51	U	0.49	U	0.46	U	0.46	U	0.52	U	0.42	U	0.6	U	0.65	U
Toluene	RIDEM RDEC	190,000	UG/KG	0.52	U	0.51	U	0.49	U	0.46	U	0.46	U	0.52	U	0.42	U	0.6	U	0.65	U
trans-1,2-Dichloroethene	EPA RSL	15,000	UG/KG	0.52	U	0.51	U	0.49	U	0.46	U	0.46	U	0.52	U	0.42	U	0.6	U	0.65	U
trans-1,3-Dichloropropene	EPA RSL	1,700 <sup>c</sup>	UG/KG	0.52	U	0.51	U	0.49	U	0.46	U	0.46	U	0.52	U	0.42	U	0.6	U	0.65	U
Trichloroethene	EPA RSL	440	UG/KG	0.52	U	0.51	U	0.49	U	1.1	J	0.46	U	0.52	U	0.42	U	0.6	U	0.65	U
Trichlorofluoromethane	EPA RSL	79,000	UG/KG	0.52	U	0.51	U	0.49	U	0.46	U	0.46	U	0.52	U	0.42	U	0.6	U	0.65	U
Vinyl Chloride	RIDEM RDEC	20	UG/KG	0.52	U	0.51	U	0.49	U	0.46	U	0.46	U	0.52	U	0.42	U	0.6	U	0.65	U
Xylenes, total	EPA RSL	63,000	UG/KG	1.52	U	1.51	U	1.47	U	1.37	U	1.37	U	1.52	U	1.26	U	1.8	U	1.95	U
TCL SVOCs by 8270D																					
1,1-Biphenyl	RIDEM RDEC	800	UG/KG	36.8	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
1,2,4,5-Tetrachlorobenzene	EPA RSL	1,800	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
2,2-oxybis(1-Chloropropane) ****	EPA RSL	4,600	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
2,3,4,6-Tetrachlorophenol	EPA RSL	180,000	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
2,4,5-Trichlorophenol	RIDEM RDEC	330,000	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
2,4,6-Trichlorophenol	EPA RSL	6,100	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
2,4-Dichlorophenol	EPA RSL	18,000	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
2,4-Dimethylphenol	EPA RSL	120,000	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
2,4-Dinitrophenol	EPA RSL	12,000	UG/KG	290	U	290	U	290	U	290	U	290	U	290	U	290	U	280	U	300	U
2,4-Dinitrotoluene	RIDEM RDEC	900	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
2,6-Dinitrotoluene	EPA RSL	330	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
2-Chloronaphthalene	EPA RSL	630,000	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
2-Chlorophenol	EPA RSL	39,000	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
2-Methylnaphthalene	EPA RSL	23,000	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
2-Methylphenol	EPA RSL	310,000	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
2-Nitroaniline	EPA RSL	61,000	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
3,3-Dichlorobenzidine	EPA RSL	1,100	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
3+4-Methylphenols	EPA RSL	610,000	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
4,6-Dinitro-2-methylphenol	EPA RSL	490	UG/KG	180	U	180	U	180	U	180	U	180	U	180	U	180	U	170	U	190	U
4-Chloro-3-methylphenol	EPA RSL	610,000	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U

WE04 Davisville  
Site 3 Summary of Analytical Results

SAMPLE ID				TP-01-PIPE		TP-02-PIPE		TP-03-PIPE		TP-04-SOIL		TP-05-SOIL		TP-06-SOIL		TP-07-SOIL		TP-08-SOIL		TP-09-SOIL	
SAMPLE DATE				10/25/2013		10/25/2013		10/25/2013		10/25/2013		10/25/2013		10/25/2013		10/25/2013		10/25/2013		10/25/2013	
MATRIX				SOIL		SOIL		SOIL		SOIL		SOIL		SOIL		SOIL		SOIL		SOIL	
TCL VOCs by 8260C	PROJECT ACTION LIMITS <sup>a</sup>		UNITS																		
4-Chloroaniline	EPA RSL	2,400	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
4-Nitroaniline	EPA RSL	24,000	UG/KG	73.7	U	72.9	U	72	U	73.3	U	72.7	U	72.2	U	72.3	U	69.6	U	74.8	U
Acenaphthene	RIDEM RDEC	43,000	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
Acenaphthylene	RIDEM RDEC	23,000	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
Acetophenone	EPA RSL	780,000	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
Anthracene	RIDEM RDEC	35,000	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
Atrazine	EPA RSL	2,100	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
Benzaldehyde	EPA RSL	780,000	UG/KG	36.9	UQ	36.5	UQ	36	UQ	36.6	UQ	36.4	UQ	36.1	UQ	36.2	UQ	34.8	UQ	37.4	UQ
Benzo(a)anthracene	EPA RSL	150 *	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
Benzo(a)pyrene	EPA RSL	15 *	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
Benzo(b)fluoranthene	EPA RSL	150 *	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
Benzo(g,h,i)perylene	RIDEM RDEC	800	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
Benzo(k)fluoranthene	RIDEM RDEC	900	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
bis(2-Chloroethoxy)methane	EPA RSL	18,000	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
bis(2-Chloroethyl)ether	EPA RSL	210 *	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
Bis(2-ethylhexyl)phthalate	EPA RSL	35,000	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
Butylbenzylphthalate	EPA RSL	260,000	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
Caprolactam	EPA RSL	3,100,000	UG/KG	73.7	U	72.9	U	72	U	73.3	U	72.7	U	72.2	U	72.3	U	69.6	U	74.8	U
Chrysene	RIDEM RDEC	400	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
Dibenzo(a,h)anthracene	EPA RSL	15 *	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
Dibenzofuran	EPA RSL	7,800	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
Diethylphthalate	RIDEM RDEC	340,000	UG/KG	36.9	U	36.5	U	2100		620		36.4	U	36.1	U	36.2	U	34.8	U	840	
Dimethylphthalate	RIDEM RDEC	1,900,000	UG/KG	390		380		320	J	390		440		400		380		320	J	370	
Di-n-butylphthalate	EPA RSL	610,000	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
Di-n-octyl phthalate	EPA RSL	61,000	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
Fluoranthene	RIDEM RDEC	20,000	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
Fluorene	RIDEM RDEC	28,000	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
Hexachlorobenzene	EPA RSL	300 *	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
Hexachlorobutadiene	EPA RSL	6,100	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
Hexachlorocyclopentadiene	EPA RSL	37,000	UG/KG	36.9	UQ	36.5	UQ	36	UQ	36.6	UQ	36.4	UQ	36.1	UQ	36.2	UQ	34.8	UQ	37.4	UQ
Hexachloroethane	EPA RSL	4,300	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
Indeno(1,2,3-cd)pyrene	EPA RSL	150 *	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
Isophorone	EPA RSL	510,000	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
Naphthalene	EPA RSL	3,600	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
Nitrobenzene	EPA RSL	4,800	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
n-Nitroso-di-n-propylamine	EPA RSL	69 *	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U

WE04 Davisville  
Site 3 Summary of Analytical Results

SAMPLE ID				TP-01-PIPE		TP-02-PIPE		TP-03-PIPE		TP-04-SOIL		TP-05-SOIL		TP-06-SOIL		TP-07-SOIL		TP-08-SOIL		TP-09-SOIL	
SAMPLE DATE				10/25/2013		10/25/2013		10/25/2013		10/25/2013		10/25/2013		10/25/2013		10/25/2013		10/25/2013		10/25/2013	
MATRIX				SOIL		SOIL		SOIL		SOIL		SOIL		SOIL		SOIL		SOIL		SOIL	
TCL VOCs by 8260C	PROJECT ACTION LIMITS <sup>a</sup>		UNITS																		
n-Nitrosodiphenylamine	EPA RSL	99,000	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
Pentachlorophenol	EPA RSL	890	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
Phenanthrene	RIDEM RDEC	40,000	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
Phenol	EPA RSL	1,800,000	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	34.8	U	37.4	U
Pyrene	RIDEM RDEC	13,000	UG/KG	36.9	U	36.5	U	36	U	36.6	U	36.4	U	36.1	U	36.2	U	73.7	J	37.4	U
TCL Pesticides by 8081B																					
4,4-DDD	EPA RSL	2,000	UG/KG	0.364	U	0.361	U	0.356	U	0.363	U	0.36	U	0.358	U	0.359	U	0.344	U	0.37	U
4,4-DDE	EPA RSL	1,400	UG/KG	0.364	U	0.361	U	0.356	U	0.363	U	0.36	U	0.358	U	0.359	U	0.344	U	0.37	U
4,4-DDT	EPA RSL	1,700	UG/KG	0.364	U	0.361	U	0.356	U	0.363	U	0.36	U	0.358	U	0.359	U	0.344	U	0.37	U
alpha-BHC	EPA RSL	77	UG/KG	0.364	U	0.361	U	0.356	U	0.363	U	0.36	U	0.358	U	0.359	U	0.344	U	0.37	U
Aldrin	EPA RSL	29	UG/KG	0.364	U	0.361	U	0.356	U	0.363	U	0.36	U	0.358	U	0.359	U	0.344	U	0.37	U
beta-BHC	EPA RSL	270	UG/KG	0.364	U	0.361	U	0.356	U	0.363	U	0.36	U	0.358	U	0.359	U	0.344	U	0.37	U
Chlordane, technical	RIDEM RDEC	500	UG/KG	3.7	U	3.6	U	3.6	U	3.7	U	3.6	U	3.6	U	3.6	U	3.5	U	3.7	U
Dieldrin	EPA RSL	30	UG/KG	0.364	U	0.361	U	0.356	U	0.363	U	0.36	U	0.358	U	0.359	U	0.344	U	0.37	U
Endosulfan I	EPA RSL	37,000 <sup>d</sup>	UG/KG	0.364	U	0.361	U	0.356	U	0.363	U	0.36	U	0.358	U	0.359	U	0.344	U	0.37	U
Endosulfan II	EPA RSL	37,000 <sup>d</sup>	UG/KG	0.364	U	0.361	U	0.356	U	0.363	U	0.36	U	0.358	U	0.359	U	0.344	U	0.37	U
Endrin	EPA RSL	1,800	UG/KG	0.364	U	0.361	U	0.356	U	0.363	U	0.36	U	0.358	U	0.359	U	0.344	U	0.37	U
gamma-BHC (Lindane)	EPA RSL	520	UG/KG	0.364	U	0.361	U	0.356	U	0.363	U	0.36	U	0.358	U	0.359	U	0.344	U	0.37	U
Heptachlor	EPA RSL	110	UG/KG	0.364	U	0.361	U	0.356	U	0.363	U	0.36	U	0.358	U	0.359	U	0.344	U	0.37	U
Heptachlor epoxide	EPA RSL	53	UG/KG	0.364	U	0.361	U	0.356	U	0.363	U	0.36	U	0.358	U	0.359	U	0.344	U	0.37	U
Methoxychlor	EPA RSL	31,000	UG/KG	0.364	U	0.361	U	0.356	U	0.363	U	0.36	U	0.358	U	0.359	U	0.344	U	0.37	U
Toxaphene	EPA RSL	440	UG/KG	3.7	U	3.6	U	3.6	U	3.7	U	3.6	U	3.6	U	3.6	U	3.5	U	3.7	U
TCL PCBs by 8082A																					
Aroclor-1016	EPA RSL	390	UG/KG	3.7	U	3.6	U	3.6	U	3.7	U	3.6	U	3.6	U	3.6	U	3.5	U	3.7	U
Aroclor-1221	EPA RSL	140	UG/KG	3.7	U	3.6	U	3.6	U	3.7	U	3.6	U	3.6	U	3.6	U	3.5	U	3.7	U
Aroclor-1232	EPA RSL	140	UG/KG	3.7	U	3.6	U	3.6	U	3.7	U	3.6	U	3.6	U	3.6	U	3.5	U	3.7	U
Aroclor-1242	EPA RSL	220	UG/KG	3.7	U	3.6	U	3.6	U	3.7	U	3.6	U	3.6	U	3.6	U	3.5	U	3.7	U
Aroclor-1248	EPA RSL	220	UG/KG	3.7	U	3.6	U	3.6	U	3.7	U	3.6	U	3.6	U	3.6	U	3.5	U	3.7	U
Aroclor-1254	EPA RSL	110	UG/KG	3.7	U	3.6	U	3.6	U	3.7	U	3.6	U	3.6	U	3.6	U	3.5	U	3.7	U
Aroclor-1260	EPA RSL	220	UG/KG	12.8	JP	26.2		28.5	P	14.2	JP	12	JP	15.2	JP	44.6		61.1		44.9	
TAL Metals and Mercury by 6010C/7471B																					
Aluminum	EPA RSL	7,700	MG/KG	12,000	DN	10,400	DN	11,500	DN	9,000	DN	11,100	DN	8,300	DN	7,200	DN	7,800	DN	8,900	DN
Antimony	EPA RSL	3.1	MG/KG	1.13	UN	1.17	UN	1.15	UN	1.17	UN	1.16	UN	1.14	UN	1.12	UN	1.12	UN	1.18	UN
Arsenic	EPA RSL	0.61 *	MG/KG	1.74	N	2.32	N	3.7	N	1.68	N	1.87	N	1.63	N	1.83	N	1.94	N	2.32	N
Barium	EPA RSL	1,500	MG/KG	20.5		13.8		20.9		15.6		17		14.1		15.3		16		19.4	
Beryllium	RIDEM RDEC	1.5	MG/KG	0.532	N	0.377	N	0.502	N	0.397	N	0.438	N	0.36	N	0.33	N	0.324	N	0.362	N

WE04 Davisville  
Site 3 Summary of Analytical Results

SAMPLE ID				TP-01-PIPE		TP-02-PIPE		TP-03-PIPE		TP-04-SOIL		TP-05-SOIL		TP-06-SOIL		TP-07-SOIL		TP-08-SOIL		TP-09-SOIL	
SAMPLE DATE				10/25/2013		10/25/2013		10/25/2013		10/25/2013		10/25/2013		10/25/2013		10/25/2013		10/25/2013		10/25/2013	
MATRIX				SOIL		SOIL		SOIL		SOIL		SOIL		SOIL		SOIL		SOIL		SOIL	
TCL VOCs by 8260C		PROJECT ACTION LIMITS <sup>a</sup>		UNITS																	
Cadmium	EPA RSL	7	MG/KG	0.136	U	0.14	U	0.138	U	0.14	U	0.14	U	0.137	U	0.135	U	0.134	U	0.142	U
Chromium <sup>e</sup>	RIDEM RDEC	1,400	MG/KG	9.13	N	7.42	N	10.85	N	7.01	N	8.36	N	6.17	N	5.98	N	6.59	N	7.62	N
Cobalt	EPA RSL	2.3	MG/KG	10.86		6.65		11.7		6.79		7.95		5.73		4.61		5.64		6.25	
Copper	EPA RSL	310	MG/KG	18.8		10.89		19.9		11.3		13		10.28		10.5		14.4		13.1	
Iron	EPA RSL	5,500	MG/KG	28,700	DN	17,400	DN	22,900	DN	14,800	DN	18,400	DN	14,400	DN	12,500	DN	13,600	DN	15,800	DN
Lead	RIDEM RDEC	150	MG/KG	24.2		28.1		20.5		15.7		19		15.3		33.5		41.8		50	
Manganese	EPA RSL	180	MG/KG	179		137		371	D	181		158		124		107		134		159	
Mercury	EPA RSL	1	MG/KG	0.005	J	0.013		0.007	J	0.011		0.011		0.011		0.012		0.028		0.014	
Nickel	EPA RSL	150	MG/KG	17.7		11.6		20.5		11		13.4		9.63		7.71		8.91		10.87	
Selenium	EPA RSL	39	MG/KG	1.51	N	1.1	N	1.47	N	1.12	N	1.25	N	0.902	JN	0.976	N	1.02	N	1.08	N
Silver	EPA RSL	39	MG/KG	1.63		0.954		1.38		0.882		1.09		0.813		0.724		0.819		0.935	
Thallium	EPA RSL	0.078 **	MG/KG	0.908	U	0.936	U	0.917	U	0.933	U	0.93	U	0.912	U	0.899	U	0.893	U	0.944	U
Vanadium	EPA RSL	39	MG/KG	17.5		15.2		20.2		14.7		16.4		12.8		11.2		12.8		15	
Zinc	EPA RSL	2,300	MG/KG	55.7		37.5		47		39		45.2		37.6		41.4		56.5		46.1	
Cyanide by 9012B																					
Cyanide	EPA RSL	2.2	MG/KG	0.138	U	0.137	U	0.136	U	0.138	U	0.059	J	0.136	U	0.136	U	0.096	J	0.195	J
Total Petroleum Hydrocarbons by 8015B																					
Petroleum hydrocarbons <sup>f</sup>	RIDEM RDEC	500	MG/KG	7.426		8.379		6.961		8.758		9.243		9.2		9.987		29.346		9.97	

WE04 Davisville  
Site 3 Summary of Analytical Results

QUALIFIER DEFINITIONS:

- Since the analytical results were not validated, the qualifiers listed below represent the laboratory qualifiers.
- B - The analyte was found in the laboratory blank as well as the sample. This indicates possible laboratory contamination of the environmental sample.
- D - The reported value is from a secondary analysis with a dilution factor. The original analysis exceeded the calibration range.
- J - The result is less than the limit of quantitation (LOQ) but greater than detection limit (DL); therefore, the result is flagged with a J to indicate estimated.
- N - The matrix spike recovery was outside control limits.
- P - For dual column analysis, the percent difference between the quantitated concentrations on the two columns is greater than 40%.
- Q - Indicates LCS control criteria did not meet requirements.
- U - The compound was not detected above the listed concentration.

NOTES:

Result is above the project action limit.

Sample ID DRUM-99-SOIL (FD) is a field duplicate of sample ID DRUM-07-SOIL.

All results are percent moisture (dry weight) corrected.

TCL and TAL lists are from the EPA Contract Laboratory Program lists for these analytes found using the following link: <http://www.epa.gov/superfund/programs/clp/target.htm> . The following analytes from those lists did not have an associated RIDEM RDEC or EPA Residential RSL value, and therefore will not be reported by the laboratory (and as such are not listed in the above tables): Methylcyclohexane from TCL VOCs; 2-Nitrophenol, 3-Nitroaniline, 4-Bromophenyl-phenylether, 4-Chlorophenyl-phenylether, 4-Nitrophenol, and Carbazole from TCL SVOCs; delta-BHC, Endosulfan sulfate, Endrin aldehyde, and Endrin ketone from TCL Pesticides; Calcium, Magnesium, Potassium, and Sodium from TAL Metals. In addition, the TCL PCB list included Aroclor-1262 and Aroclor-1268; however, the RIDEM RDEC values were listed for total PCBs and the EPA Residential RSL table did not include these two aroclors. These are very uncommon aroclors, and since they were not defined in either table, they are not included in the list of PCBs.

\* The project action limit listed is below the project quantitation limit or laboratory LOQ but is above the laboratory DL. Since results detected between the DL and LOQ will be reported as estimated with a J flag, the data can still be evaluated against the project action limit.

\*\* The project action limit listed for Thallium is below the laborartory DL (which is the lowest achievable limit). Therefore, Thallium will be evaluated against the LOQ.

\*\*\* This analyte is the same as 1,1,2-Trichloro-1,2,2-trifluoroethane as listed in the Sampling and Analysis Plan.

\*\*\*\* This analyte is the same as bis(2-Chloroisopropyl)ether as listed in the Sampling and Analysis Plan.

<sup>a</sup> Project action limits listed in this table were chosen from the lower of the RIDEM RDEC or EPA RSL for residential/recreational child/adult exposure to soil. References for the RIDEM RDEC values are found in Table 1 starting on Page 43 under the residential column of the following document dated November 2011: <http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CC4QFjAA&url=http%3A%2F%2Fwww.dem.ri.gov%2Fpubs%2Fregs%2Fregs%2Fwaste%2Fremreg11.pdf&ei=oPBeUrXOPIrIyAHgoIH4DQ&usg=AFQjCNEDV--zTyuSEtLIT-c-F6m5e8Q3fw&bvm=bv.54176721,d.aWc&cad=rja> . The EPA RSL values are found in the summary table dated May 2013 under the New Tables tab for Target Cancer Risk (TR) = 1E-06 and Target Hazard Quotient (THQ) = 0.1 using the following link: [http://www.epa.gov/reg3hwmd/risk/human/rb-concentration\\_table/Generic\\_Tables/index.htm](http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm) .

<sup>b</sup> These analytes were not part of the TCL lists; however they were listed in the RIDEM RDEC list of compounds so they were included herein.

<sup>c</sup> The EPA RSL value list for this compound is based on total 1,3-dichloropropene (and not cis and trans isomers that are reported by the laboratory).

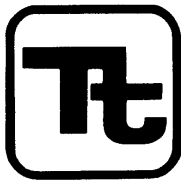
<sup>d</sup> Value listed is for total Endosulfan (not as Endosulfan I and Endosulfan II isomers that will be reported by the laboratory).

<sup>e</sup> Although the RIDEM RDEC list has a value for Chromium III and Chromium VI, the only chromium reported for this project will be Chromium III. Therefore, the associated project action limit listed in this table is for Chromium III from the RIDEM RDEC list.

<sup>f</sup> Analyses was requested to be performed outside of holding time for this analytical method.

## **APPENDIX D**

### **SITE-SPECIFIC FIELD STANDARD OPERATING PROCEDURES**



**TETRA TECH**

# STANDARD OPERATING PROCEDURES

Number SOP-01  
HS-1.0

Page  
1 of 15

Effective Date  
01/2012

Revision  
3

Applicability  
Tetra Tech, Inc.

Prepared  
Health & Safety

Subject  
UTILITY LOCATING AND EXCAVATION CLEARANCE

Approved  
J. Zimmerly

## TABLE OF CONTENTS

<b><u>SECTION</u></b>	<b><u>PAGE</u></b>
<b>1.0 PURPOSE.....</b>	<b>2</b>
<b>2.0 SCOPE.....</b>	<b>2</b>
<b>3.0 GLOSSARY .....</b>	<b>2</b>
<b>4.0 RESPONSIBILITIES.....</b>	<b>3</b>
<b>5.0 PROCEDURES.....</b>	<b>3</b>
5.1 BURIED UTILITIES.....	3
5.2 OVERHEAD POWER LINES.....	5
<b>6.0 UNDERGROUND LOCATING TECHNIQUES.....</b>	<b>5</b>
6.1 GEOPHYSICAL METHODS .....	5
6.2 PASSIVE DETECTION SURVEYS.....	6
6.3 INTRUSIVE DETECTION SURVEYS.....	6
<b>7.0 INTRUSIVE ACTIVITIES SUMMARY.....</b>	<b>7</b>
<b>8.0 REFERENCES.....</b>	<b>8</b>

## **ATTACHMENTS**

1	Listing of Underground Utility Clearance Resources .....	9
2	Frost Line Penetration Depths by Geographic Location .....	11
3	Utility Clearance Form.....	12
4	OSHA Letter of Interpretation .....	13



Subject  UTILITY LOCATING AND EXCAVATION CLEARANCE	Number HS-1.0	Page 2 of 15
	Revision 3	Effective Date 01/2012

## 1.0 PURPOSE

Utilities such as electric service lines, natural or propane gas lines, water and sewage lines, telecommunications, and steam lines are very often in the immediate vicinity of work locations. Contact with underground or overhead utilities can have serious consequences including employee injury/fatality, property and equipment damage, substantial financial impacts, and loss of utility service to users.

The purpose of this procedure is to provide minimum requirements and technical guidelines regarding the appropriate procedures to be followed when performing subsurface and overhead utility locating services. It is the policy of Tetra Tech NUS, Inc. (TtNUS) to provide a safe and healthful work environment for the protection of our employees. The purpose of this Standard Operating Procedure (SOP) is to aid in achieving the objectives of this policy, to present the acceptable procedures pertaining to utility locating and excavation clearance activities, and to present requirements and restrictions relevant to these types of activities. This SOP must be reviewed by any employee potentially involved with underground or overhead utility locating and avoidance activities.

## 2.0 SCOPE

This procedure applies to all TtNUS field activities where there may be potential contact with underground or overhead utilities. This procedure provides a description of the principles of operation, instrumentation, applicability, and implementability of typical methods used to determine the presence and avoidance of contact with utility services. This procedure is intended to assist with work planning and scheduling, resource planning, field implementation, and subcontractor procurement. Utility locating and excavation clearance requires site-specific information prior to the initiation of any such activities on a specific project. This SOP is not intended to provide a detailed description of methodology and instrument operation. Specialized expertise during both planning and execution of several of the methods presented may also be required.

## 3.0 GLOSSARY

Electromagnetic Induction (EMI) Survey - A geophysical exploration method whereby electromagnetic fields are induced in the ground and the resultant secondary electromagnetic fields are detected as a measure of ground conductivity.

Magnetometer – A device used for precise and sensitive measurements of magnetic fields.

Magnetic Survey – A geophysical survey method that depends on detection of magnetic anomalies caused by the presence of buried ferromagnetic objects.

Metal Detection – A geophysical survey method that is based on electromagnetic coupling caused by underground conductive objects.

Vertical Gradiometer – A magnetometer equipped with two sensors that are vertically separated by a fixed distance. It is best suited to map near surface features and is less susceptible to deep geologic features.

Ground Penetrating Radar – Ground Penetrating Radar (GPR) involves specialized radar equipment whereby a signal is sent into the ground via a transmitter. Some portion of the signal will be reflected from the subsurface material, which is then recorded with a receiver and electronically converted into a graphic picture.

Subject  UTILITY LOCATING AND EXCAVATION CLEARANCE	Number HS-1.0	Page 3 of 15
	Revision 3	Effective Date 01/2012

#### 4.0 RESPONSIBILITIES

Project Manager (PM)/Task Order Manager (TOM) - Responsible for ensuring that all field activities are conducted in accordance with this procedure.

Site Manager (SM)/Field Operations Leader (FOL) - Responsible for the onsite verification that all field activities are performed in compliance with approved SOPs or as otherwise directed by the approved project plan(s).

Site Health & Safety Officer (SHSO) – Responsible to provide technical assistance and verify full compliance with this SOP. The SHSO is also responsible for reporting any deficiencies to the Corporate Health and Safety Manager (HSM) and to the PM/TOM.

Health & Safety Manager (HSM) – Responsible for preparing, implementing, and modifying corporate health and safety policy and this SOP.

Site Personnel – Responsible for performing their work activities in accordance with this SOP and the TtNUS Health and Safety Policy.

#### 5.0 PROCEDURES

This procedure addresses the requirements and technical procedures that must be performed to minimize the potential for contact with underground and overhead utility services. These procedures are addressed individually from a buried and overhead standpoint.

##### 5.1 Buried Utilities

Buried utilities present a heightened concern because their location is not typically obvious by visual observation, and it is common that their presence and/or location is unknown or incorrectly known on client properties. This procedure must be followed prior to beginning any subsurface probing or excavation that might potentially be in the vicinity of underground utility services. In addition, the Utility Clearance Form (Attachment 3) must be completed for every location or cluster of locations where intrusive activities will occur.

Where the positive identification and de-energizing of underground utilities cannot be obtained and confirmed using the following steps, the PM/TOM is responsible for arranging for the procurement of a qualified, experienced, utility locating subcontractor who will accomplish the utility location and demarcation duties specified herein.

1. A comprehensive review must be made of any available property maps, blue lines, or as-builts prior to site activities. Interviews with local personnel familiar with the area should be performed to provide additional information concerning the location of potential underground utilities. Information regarding utility locations shall be added to project maps upon completion of this exercise.
- 2., A visual site inspection must be performed to compare the site plan information to actual field conditions. Any findings must be documented and the site plan/maps revised. The area(s) of proposed excavation or other subsurface activities must be marked at the site in white paint or pin flags to identify those locations of the proposed intrusive activities. The site inspection should focus on locating surface indications of potential underground utilities. Items of interest include the presence of nearby area lights, telephone service, drainage grates, fire hydrants, electrical service vaults/panels, asphalt/concrete scares and patches, and topographical depressions. Note the location of any emergency shut off switches. Any additional information regarding utility

Subject  UTILITY LOCATING AND EXCAVATION CLEARANCE	Number HS-1.0	Page 4 of 15
	Revision 3	Effective Date 01/2012

locations shall be added to project maps upon completion of this exercise and returned to the PM/TOM.

3. If the planned work is to be conducted on private property (e.g., military installations, manufacturing facilities, etc.) the FOL must identify and contact appropriate facility personnel (e.g., public works or facility engineering) before any intrusive work begins to inquire about (and comply with) property owner requirements. It is important to note that private property owners may require several days to several weeks advance notice prior to locating utilities.
4. If the work location is on public property, the state agency that performs utility clearances must be notified (see Attachment 1). State "one-call" services must be notified prior to commencing fieldwork per their requirements. Most one-call services require, by law, 48- to 72-hour advance notice prior to beginning any excavation. Such services typically assign a "ticket" number to the particular site. This ticket number must be recorded for future reference and is valid for a specific period of time, but may be extended by contacting the service again. The utility service will notify utility representatives who then mark their respective lines within the specified time frame. It should be noted that most military installations own their own utilities but may lease service and maintenance from area providers. Given this situation, "one call" systems may still be required to provide location services on military installations.
5. Utilities must be identified and their locations plainly marked using pin flags, spray paint, or other accepted means. The location of all utilities must be noted on a field sketch for future inclusion on project maps. Utility locations are to be identified using the following industry-standard color code scheme, unless the property owner or utility locator service uses a different color code:

white	excavation/subsurface investigation location
red	electrical
yellow	gas, oil, steam
orange	telephone, communications
blue	water, irrigation, slurry
green	sewer, drain
6. Where utility locations are not confirmed with a high degree of confidence through drawings, schematics, location services, etc., the work area must be thoroughly investigated prior to beginning the excavation. In these situations, utilities must be identified using safe and effective methods such as passive and intrusive surveys, or the use of non-conductive hand tools. Also, in situations where such hand tools are used, they should always be used in conjunction with suitable detection equipment, such as the items described in Section 6.0 of this SOP. Each method has advantages and disadvantages including complexity, applicability, and price. It also should be noted that in some states, initial excavation is required by hand to a specified depth.
7. At each location where trenching or excavating will occur using a backhoe or other heavy equipment, and where utility identifications and locations cannot be confirmed prior to groundbreaking, the soil must be probed using a device such as a tile probe which is made of non-conductive material such as fiberglass. If these efforts are not successful in clearing the excavation area of suspect utilities, hand shoveling must be performed for the perimeter of the intended excavation.
8. All utilities uncovered or undermined during excavation must be structurally supported to prevent potential damage. Unless necessary as an emergency corrective measure, TtNUS shall not make any repairs or modifications to existing utility lines without prior permission of the utility owner, property owner, and Corporate HSM. All repairs require that the line be locked-out/tagged-out prior to work.

Subject  UTILITY LOCATING AND EXCAVATION CLEARANCE	Number HS-1.0	Page 5 of 15
	Revision 3	Effective Date 01/2012

## 5.2 Overhead Power Lines

If it is necessary to work within the minimum clearance distance of an overhead power line, the overhead line must be de-energized and grounded, or re-routed by the utility company or a registered electrician. If protective measures such as guarding, isolating, or insulating are provided, these precautions must be adequate to prevent employees from contacting such lines directly with any part of their body or indirectly through conductive materials, tools, or equipment.

The following table provides the required minimum clearances for working in proximity to overhead power lines.

<u>Nominal Voltage</u>	<u>Minimum Clearance</u>
0 -50 kV	10 feet, or one mast length; whichever is greater
50+ kV	10 feet plus 4 inches for every 10 kV over 50 kV or 1.5 mast lengths; whichever is greater

## 6.0 UNDERGROUND LOCATING TECHNIQUES

A variety of supplemental utility locating approaches are available and can be applied when additional assurance is needed. The selection of the appropriate method(s) to employ is site-specific and should be tailored to the anticipated conditions, site and project constraints, and personnel capabilities.

### 6.1 Geophysical Methods

Geophysical methods include electromagnetic induction, magnetics, and ground penetrating radar. Additional details concerning the design and implementation of electromagnetic induction, magnetics, and ground penetrating radar surveys can be found in one or more of the TtNUS SOPs included in the References (Section 8.0).

#### **Electromagnetic Induction**

Electromagnetic Induction (EMI) line locators operate either by locating a background signal or by locating a signal introduced into the utility line using a transmitter. A utility line acts like a radio antenna, producing electrons, which can be picked up with a radiofrequency receiver. Electrical current carrying conductors have a 60HZ signal associated with them. This signal occurs in all power lines regardless of voltage. Utilities in close proximity to power lines or used as grounds may also have a 60HZ signal, which can be picked up with an EM receiver. A typical example of this type of geophysical equipment is an EM-61.

EMI locators specifically designed for utility locating use a special signal that is either indirectly induced onto a utility line by placing the transmitter above the line or directly induced using an induction clamp. The clamp induces a signal on the specific utility and is the preferred method of tracing since there is little chance of the resulting signals being interfered with. A good example of this type of equipment is the Schonstedt® MAC-51B locator. The MAC-51B performs inductively traced surveys, simple magnetic locating, and traced nonmetallic surveys.

When access can be gained inside a conduit to be traced, a flexible insulated trace wire can be used. This is very useful for non-metallic conduits but is limited by the availability of gaining access inside the pipe.

Subject  UTILITY LOCATING AND EXCAVATION CLEARANCE	Number HS-1.0	Page 6 of 15
	Revision 3	Effective Date 01/2012

## **Magnetics**

Magnetic locators operate by detecting the relative amounts of buried ferrous metal. They are incapable of locating or identifying nonferrous utility lines but can be very useful for locating underground storage tanks (UST's), steel utility lines, and buried electrical lines. A typical example of this type of equipment is the Schonstedt® GA-52Cx locator. The GA-52Cx is capable of locating 4-inch steel pipe up to 8 feet deep.

Non-ferrous lines are often located by using a typical plumbing tool (snake) fed through the line. A signal is then introduced to the snake that is then traced.

## **Ground Penetrating Radar**

Ground Penetrating Radar (GPR) involves specialized radar equipment whereby a signal is sent into the ground via a transmitter. Some portion of the signal will be reflected from the subsurface material, which is then recorded with a receiver and electronically converted into a graphic picture. In general, an object which is harder than the surrounding soil will reflect a stronger signal. Utilities, tunnels, UST's, and footings will reflect a stronger signal than the surrounding soil. Although this surface detection method may determine the location of a utility, this method does not specifically identify utilities (i.e., water vs. gas, electrical vs. telephone); hence, verification may be necessary using other methods. This method is somewhat limited when used in areas with clay soil types or with a high water table.

## **6.2 Passive Detection Surveys**

### **Acoustic Surveys**

Acoustic location methods are generally most applicable to waterlines or gas lines. A highly sensitive Acoustic Receiver listens for background sounds of water flowing (at joints, leaks, etc.) or to sounds introduced into the water main using a transducer. Acoustics may also be applicable to determine the location of plastic gas lines.

### **Thermal Imaging**

Thermal (i.e., infrared) imaging is a passive method for detecting the heat emitted by an object. Electronics in the infrared camera convert subtle heat differentials into a visual image on the viewfinder or a monitor. The operator does not look for an exact temperature; rather they look for heat anomalies (either elevated or suppressed temperatures) characteristic of a potential utility line.

The thermal fingerprint of underground utilities results from differences in temperature between the atmosphere and the fluid present in a pipe or the heat generated by electrical resistance. In addition, infrared scanners may be capable of detecting differences in the compaction, temperature and moisture content of underground utility trenches. High-performance thermal imagery can detect temperature differences to hundredths of a degree.

## **6.3 Intrusive Detection Surveys**

### **Vacuum Excavation**

Vacuum excavation is used to physically expose utility services. The process involves removing the surface material over approximately a 1' x 1' area at the site location. The air-vacuum process proceeds with the simultaneous action of compressed air-jets to loosen soil and vacuum extraction of the resulting

Subject  UTILITY LOCATING AND EXCAVATION CLEARANCE	Number HS-1.0	Page 7 of 15
	Revision 3	Effective Date 01/2012

debris. This process ensures the integrity of the utility line during the excavation process, as no hammers, blades, or heavy mechanical equipment comes into contact with the utility line, eliminating the risk of damage to utilities. The process continues until the utility is uncovered. Vacuum excavation can be used at the proposed site location to excavate below the "utility window" which is usually 8 feet.

### **Hand Excavation**

When the identification and location of underground utilities cannot be positively confirmed through document reviews and/or other methods, borings and excavations may be cleared via the use of non-conductive hand tools. This should always be done in conjunction with the use of detection equipment. This would be required for all locations where there is a potential to impact buried utilities. The minimum hand-excavation depth that must be reached is to be determined considering the geographical location of the work site. This approach recognizes that the placement of buried utilities is influenced by frost line depths that vary by geographical region. Attachment 2 presents frost line depths for the regions of the contiguous United States. At a minimum, hand excavation depths must be at least to the frost line depth (see Attachment 2) plus two (2) feet, but never less than 4 feet below ground surface (bgs). For hand excavation, the hole created must be reamed large enough to be at least the diameter of the drill rig auger or bit prior to drilling. For soil gas surveys, the survey probe shall be placed as close as possible to the cleared hand excavation. It is important to note that a post-hole digger must not be used in this type of hand excavation activity.

### **Tile Probe Surveys**

For some soil types, site conditions, and excavation requirements, non-conductive tile probes may be used. A tile probe is a "T"-handled rod of varying lengths that can be pushed into the soil to determine if any obstructions exist at that location. Tile probes constructed of fiberglass or other nonconductive material are readily-available from numerous vendors. Tile probes must be performed to the same depth requirements as previously specified. As with other types of hand excavating activities, the use of a non-conductive tile probe, should always be in conjunction with suitable utility locating detection equipment.

## **7.0 INTRUSIVE ACTIVITIES SUMMARY**

The following list summarizes the activities that must be performed prior to beginning subsurface activities:

1. Map and mark all subsurface locations and excavation boundaries using white paint or markers specified by the client or property owner.
2. Notify the property owner and/or client that the locations are marked. At this point, drawings of locations or excavation boundaries shall be provided to the property owner and/or client so they may initiate (if applicable) utility clearance.

Note: Drawings with confirmed locations should be provided to the property owner and/or client as soon as possible to reduce potential time delays.

3. Notify "One Call" service. If possible, arrange for an appointment to show the One Call representative the surface locations or excavation boundaries in person. This will provide a better location designation to the utilities they represent. You should have additional drawings should you need to provide plot plans to the One Call service.
4. Implement supplemental utility detection techniques as necessary and appropriate to conform utility locations or the absence thereof.

Subject  UTILITY LOCATING AND EXCAVATION CLEARANCE	Number HS-1.0	Page 8 of 15
	Revision 3	Effective Date 01/2012

5. Complete Attachment 3, Utility Clearance Form. This form should be completed for each excavation location. In situations where multiple subsurface locations exist within the close proximity of one another, one form may be used for multiple locations provided those locations are noted on the Utility Clearance Form. Upon completion, the Utility Clearance Form and revised/annotated utility location map becomes part of the project file.

## 8.0 REFERENCES

OSHA Letter of Interpretation, Mr. Joseph Caldwell, Attachment 4  
 OSHA 29 CFR 1926(b)(2)  
 OSHA 29 CFR 1926(b)(3)  
 Tt Utility Locating and Clearance Policy  
 Tt SOP GH-3.1; Resistivity and Electromagnetic Induction  
 Tt SOP GH-3.2; Magnetic and Metal Detection Surveys  
 Tt SOP GH-3.4; Ground-penetrating Radar Surveys



Subject  UTILITY LOCATING AND EXCAVATION CLEARANCE	Number  HS-1.0	Page  9 of 15
	Revision  3	Effective Date  01/2012

## ATTACHMENT 1 LISTING OF UNDERGROUND UTILITY CLEARANCE RESOURCES



**American Public Works Association**  
 2345 Grand Boulevard, Suite 500, Kansas City, MO 64108-2625  
 Phone (816) 472-6100 • Fax (816) 472-1610  
 Web [www.apwa.net](http://www.apwa.net) • E-mail [apwa@apwa.net](mailto:apwa@apwa.net)

### ONE-CALL SYSTEMS INTERNATIONAL CONDENSED DIRECTORY

**Alabama**  
 Alabama One-Call  
 1-800-292-8525

**Alaska**  
 Locate Call Center of Alaska, Inc.  
 1-800-478-3121

**Arizona**  
 Arizona Blue Stake  
 1-800-782-5348

**Arkansas**  
 Arkansas One Call System, Inc.  
 1-800-482-8998

**California**  
 Underground Service Alert North  
 1-800-227-2600  
 Underground Service Alert of Southern  
 California  
 1-800-227-2600

**Colorado**  
 Utility Notification Center of Colorado  
 1-800-922-1987

**Connecticut**  
 Call Before You Dig  
 1-800-922-4455

**Delaware**  
 Miss Utility of Delmarva  
 1-800-282-8555

**Florida**  
 Sunshine State One-Call of Florida, Inc.  
 1-800-432-4770

**Georgia**  
 Underground Protection Center, Inc.  
 1-800-282-7411

**Hawaii**  
 Underground Service Alert North  
 1-800-227-2600

**Idaho**  
 Dig Line Inc.  
 1-800-342-1585  
 Kootenai County One-Call  
 1-800-428-4950  
 Shoshone - Benewah One-Call  
 1-800-398-3285

**Illinois**  
 JULIE, Inc.  
 1-800-892-0123  
 Digger (Chicago Utility Alert Network)  
 312-744-7000

**Indiana**  
 Indiana Underground Plant Protection  
 Service  
 1-800-382-5544

**Iowa**  
 Iowa One-Call  
 1-800-292-8989

**Kansas**  
 Kansas One-Call System, Inc.  
 1-800-344-7233

**Kentucky**  
 Kentucky Underground Protection Inc.  
 1-800-752-6007

**Louisiana**  
 Louisiana One Call System, Inc.  
 1-800-272-3020

**Maine**  
 Dig Safe System, Inc.  
 1-888-344-7233

**Maryland**  
 Miss Utility  
 1-800-257-7777  
 Miss Utility of Delmarva  
 1-800-282-8555

**Massachusetts**  
 Dig Safe System, Inc.  
 1-888-344-7233

**Michigan**  
 Miss Dig System, Inc.  
 1-800-482-7171

**Minnesota**  
 Gopher State One Call  
 1-800-252-1166

**Mississippi**  
 Mississippi One-Call System, Inc.  
 1-800-227-6477

**Missouri**  
 Missouri One-Call System, Inc.  
 1-800-344-7483

**Montana**  
 Utilities Underground Protection Center  
 1-800-424-5555  
 Montana One Call Center  
 1-800-551-8344

**Nebraska**  
 Diggers Hotline of Nebraska  
 1-800-331-5666

**Nevada**  
 Underground Service Alert North  
 1-800-227-2600

**New Hampshire**  
 Dig Safe System, Inc.  
 1-888-344-7233

**New Jersey**  
 New Jersey One Call  
 1-800-272-1000

**New Mexico**  
 New Mexico One Call System, Inc.  
 1-800-321-2537  
 Las Cruces- Dona Ana Blue Stakes  
 1-888-526-0400

**New York**  
 Dig Safely New York  
 1-800-962-7962  
 New York City- Long Island One Call  
 Center  
 1-800-272-4480

**North Carolina**  
 The North Carolina One-Call Center,  
 Inc.  
 1-800-632-4949

**North Dakota**  
 North Dakota One-Call  
 1-800-795-0555

**Ohio**  
 Ohio Utilities Protection Service  
 1-800-362-2764  
 Oil & Gas Producers Underground  
 Protect'n Svc  
 1-800-925-0988

**Oklahoma**  
 Call Okie  
 1-800-522-6543

**Oregon**  
 Oregon Utility Notification Center/One  
 Call Concepts  
 1-800-332-2344

**Pennsylvania**  
 Pennsylvania One Call System, Inc.  
 1-800-242-1776

**Rhode Island**  
 Dig Safe System, Inc.  
 1-888-344-7233

**South Carolina**  
 Palmetto Utility Protection Service Inc.  
 1-888-721-7877

**South Dakota**  
 South Dakota One Call  
 1-800-781-7474

**Tennessee**  
 Tennessee One-Call System, Inc.  
 1-800-351-1111

Subject  UTILITY LOCATING AND EXCAVATION CLEARANCE	Number HS-1.0	Page 10 of 15
	Revision 3	Effective Date 01/2012

### ATTACHMENT 1 (Continued)

#### **Texas**

Texas One Call System  
1-800-245-4545  
Texas Excavation Safety System, Inc.  
1-800-344-8377  
Lone Star Notification Center  
1-800-669-8344

#### **Utah**

Blue Stakes of Utah  
1-800-662-4111

#### **Vermont**

Dig Safe System, Inc.  
1-888-344-7233

#### **Virginia**

Miss Utility of Virginia  
1-800-552-7001  
Miss Utility (Northern Virginia)  
1-800-257-7777

#### **Washington**

Utilities Underground Location Center  
1-800-424-5555  
Northwest Utility Notification Center  
1-800-553-4344  
Inland Empire Utility Coordinating  
Council  
509-456-8000

#### **West Virginia**

Miss Utility of West Virginia, Inc.  
1-800-245-4848

#### **Wisconsin**

Diggers Hotline, Inc.  
1-800-242-8511

#### **Wyoming**

Wyoming One-Call System, Inc.  
1-800-348-1030  
Call Before You Dig of Wyoming  
1-800-849-2476

#### **District of Columbia**

Miss Utility  
1-800-257-7777

#### **Alberta**

Alberta One-Call Corporation  
1-800-242-3447

#### **British Columbia**

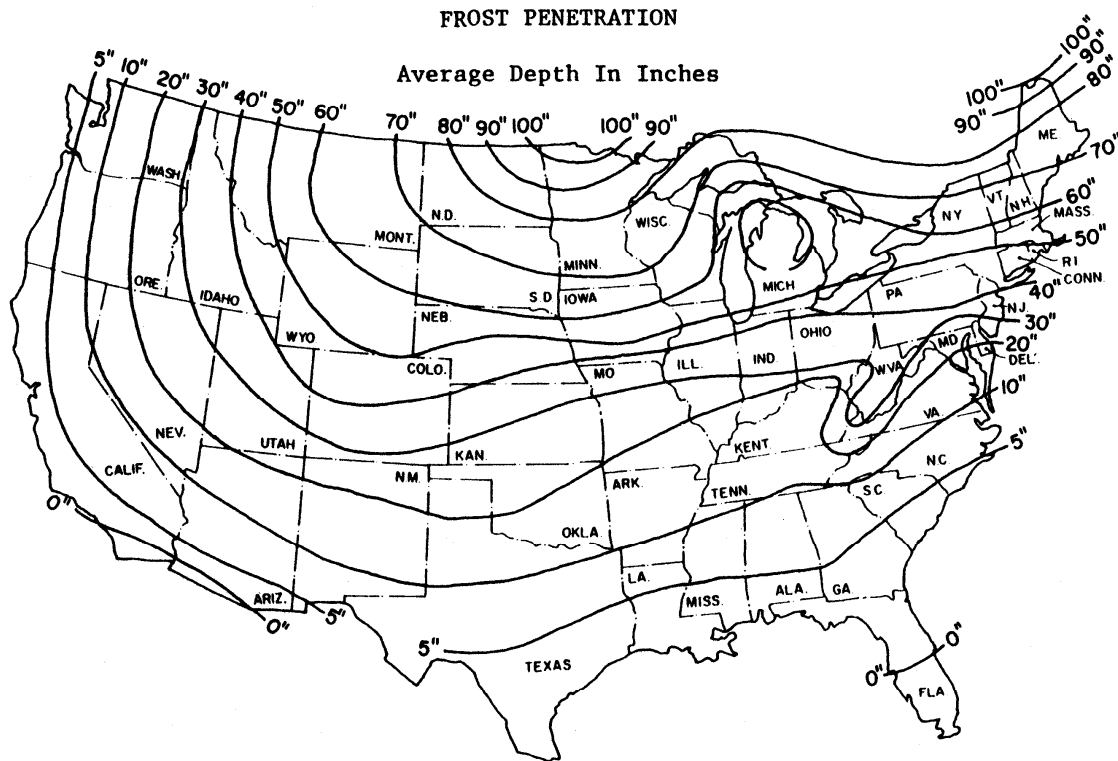
BC One Call  
1-800-474-6886

#### **Ontario**

Ontario One-Call System  
1-800-400-2255

#### **Quebec**

Info-Excavation  
1-800-663-9228

**ATTACHMENT 2****FROST LINE PENETRATION DEPTHS BY GEOGRAPHIC LOCATION**

Courtesy U.S. Department Of Commerce

Subject  UTILITY LOCATING AND EXCAVATION CLEARANCE	Number HS-1.0	Page 12 of 15
	Revision 3	Effective Date 01/2012

**ATTACHMENT 3  
UTILITY CLEARANCE FORM**

Client: \_\_\_\_\_ Project Name: \_\_\_\_\_  
 Project No.: \_\_\_\_\_ Completed By: \_\_\_\_\_  
 Location Name: \_\_\_\_\_ Work Date: \_\_\_\_\_  
 Excavation Method/Overhead Equipment: \_\_\_\_\_

1. Underground Utilities Circle One
- a) Review of existing maps? yes no N/A
- b) Interview local personnel? yes no N/A
- c) Site visit and inspection? yes no N/A
- d) Excavation areas marked in the field? yes no N/A
- e) Utilities located in the field? yes no N/A
- f) Located utilities marked/added to site maps? yes no N/A
- g) Client contact notified yes no N/A  
 Name \_\_\_\_\_ Telephone: \_\_\_\_\_ Date: \_\_\_\_\_
- g) State One-Call agency called? yes no N/A  
 Caller: \_\_\_\_\_  
 Ticket Number: \_\_\_\_\_ Date: \_\_\_\_\_
- h) Geophysical survey performed? yes no N/A  
 Survey performed by: \_\_\_\_\_  
 Method: \_\_\_\_\_ Date: \_\_\_\_\_
- i) Hand excavation performed (with concurrent use of utility yes no N/A  
 detection device)?  
 Completed by: \_\_\_\_\_  
 Total depth: \_\_\_\_\_ feet Date: \_\_\_\_\_
- j) Trench/excavation probed? yes no N/A  
 Probing completed by: \_\_\_\_\_  
 Depth/frequency: \_\_\_\_\_ Date: \_\_\_\_\_
2. Overhead Utilities Present Absent
- a) Determination of nominal voltage yes no N/A
- b) Marked on site maps yes no N/A
- c) Necessary to lockout/insulate/re-route yes no N/A
- d) Document procedures used to lockout/insulate/re-route yes no N/A
- e) Minimum acceptable clearance (SOP Section 5.2): \_\_\_\_\_

3. Notes: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Approval:

\_\_\_\_\_  
 Site Manager/Field Operations Leader

\_\_\_\_\_  
 Date

c: PM/Project File  
 Program File

Subject  UTILITY LOCATING AND EXCAVATION CLEARANCE	Number HS-1.0	Page 13 of 15
	Revision 3	Effective Date 01/2012

## ATTACHMENT 4 OSHA LETTER OF INTERPRETATION

Mr. Joseph Caldwell  
Consultant  
Governmental Liaison  
Pipeline Safety Regulations  
211 Wilson Boulevard  
Suite 700  
Arlington, Virginia 22201

Re: Use of hydro-vacuum or non-conductive hand tools to locate underground utilities.

Dear Mr. Caldwell:

In a letter dated July 7, 2003, we responded to your inquiry of September 18, 2002, regarding the use of hydro-vacuum equipment to locate underground utilities by excavation. After our letter to you was posted on the OSHA website, we received numerous inquiries that make it apparent that aspects of our July 7 letter are being misunderstood. In addition, a number of industry stakeholders, including the National Utility Contractors Association (NUCA), have provided new information regarding equipment that is available for this work.

To clarify these issues, we are withdrawing our July 7 letter and issuing this replacement response to your inquiry.

***Question:*** Section 1926.651 contains several requirements that relate to the safety of employees engaged in excavation work. Specifically, paragraphs (b)(2) and (b)(3) relate in part to the safety of the means used to locate underground utility installations that, if damaged during an uncovering operation, could pose serious hazards to employees.

*Under these provisions, what constitutes an acceptable method of uncovering underground utility lines, and further, would the use of hydro-vacuum excavation be acceptable under the standard?*

### **Answer**

#### **Background**

Two sections of 29 CFR 1926 Subpart P (Excavations), 1926.651(Specific excavation requirements), govern methods for uncovering underground utility installations. Specifically, paragraph (b)(2) states:

When utility companies or owners cannot respond to a request to locate underground utility installations within 24 hours \* \* \* or cannot establish the exact location of these installations, the employer may proceed, provided the employer does so with caution, and provided detection equipment or other acceptable means to locate utility installations are used. (emphasis added).

Paragraph (b)(3) provides:

Subject  UTILITY LOCATING AND EXCAVATION CLEARANCE	Number  HS-1.0	Page  14 of 15
	Revision  3	Effective Date  01/2012

#### ATTACHMENT 4 (Continued)

When excavation operations approach the estimated location of underground installations, the exact location of the installations shall be determined by safe and acceptable means. (emphasis added).

Therefore, “acceptable means” must be used where the location of the underground utilities have not been identified by the utility companies and detection equipment is not used.

Subpart P does not contain a definition of either “other acceptable means” or “safe and acceptable means.” The preambles to both the proposed rule and the final rule discussed the rationale behind the wording at issue. For example, the preamble to the proposed rule, 52 Fed. Reg. 12301 (April 15, 1987), noted that a 1972 version of this standard contained language that specified “careful probing or hand digging” as the means to uncover utilities. The preamble then noted that an amendment to the 1972 standard later deleted that language “to allow other, *equally effective means* of locating such installations.” The preamble continued that in the 1987 proposed rule, OSHA again proposed using language in section (b)(3) that would provide another example of an acceptable method of uncovering utilities that could be used where the utilities have not been marked and detection equipment is not being used – “probing with hand-held tools.” This method was rejected in the final version of 29 CFR 1926. As OSHA explained in the preamble to the final rule, 54 Fed. Reg. 45916 (October 31, 1989):

OSHA received two comments \* \* \* and input from ACCSH [OSHA’s Advisory Committee on Construction Safety and Health] \* \* \* on this provision. All commenters recommended dropping ‘such as probing with hand-held tools’ from the proposed provision, because this could create a hazard to employees by damaging the installation or its insulation.

In other words, the commenters objected to the use of hand tools being used unless detection equipment was used in conjunction with them. OSHA then concluded its discussion relative to this provision by agreeing with the commentators and ultimately not including any examples of “acceptable means” in the final provision.

#### Non-conductive hand tools are permitted

This raises the question of whether the standard permits the use of hand tools alone -- without also using detection equipment. NUCA and other industry stakeholders have recently informed us that non-conductive hand tools that are appropriate to be used to locate underground utilities are now commonly available.

Such tools, such as a “shooter” (which has a non-conductive handle and a snub nose) and non-conductive or insulated probes were not discussed in the rulemaking. Since they were not considered at that time, they were not part of the class of equipment that was thought to be unsafe for this purpose. Therefore, we conclude that the use of these types of hand tools, when used with appropriate caution, is an “acceptable means” for locating underground utilities.

Subject  UTILITY LOCATING AND EXCAVATION CLEARANCE	Number HS-1.0	Page 15 of 15
	Revision 3	Effective Date 01/2012

#### ATTACHMENT 4 (Continued)

##### Hydro-vacuum excavation

It is our understanding that some hydro-vacuum excavation equipment can be adjusted to use a minimum amount of water and suction pressure. When appropriately adjusted so that the equipment will not damage underground utilities (especially utilities that are particularly vulnerable to damage, such as electrical lines), use of such equipment would be considered a “acceptable means” of locating underground utilities. However, if the equipment cannot be sufficiently adjusted, then this method would not be acceptable under the standard.

##### Other technologies

We are not suggesting that these are the only devices that would be “acceptable means” under the standard. Industry stakeholders have informed us that there are other types of special excavation equipment designed for safely locating utilities as well.

We apologize for any confusion our July 7 letter may have caused. If you have further concerns or questions, please feel free to contact us again by fax at: U.S. Department of Labor, OSHA, Directorate of Construction, Office of Construction Standards and Compliance Assistance, fax # 202-693-1689. You can also contact us by mail at the above office, Room N3468, 200 Constitution Avenue, N.W., Washington, D.C. 20210, although there will be a delay in our receiving correspondence by mail.

Sincerely,

Russell B. Swanson, Director  
Directorate of Construction

**NOTE:** OSHA requirements are set by statute, standards and regulations. Our interpretation letters explain these requirements and how they apply to particular circumstances, but they cannot create additional employer obligations. This letter constitutes OSHA's interpretation of the requirements discussed. Note that our enforcement guidance may be affected by changes to OSHA rules. Also, from time to time we update our guidance in response to new information. To keep apprised of such developments, you can consult OSHA's website at <http://www.osha.gov>.

## **STANDARD OPERATING PROCEDURE**

### **SOP-02**

## **SAMPLE LABELING**

### **1.0 PURPOSE**

This Standard Operating Procedure (SOP) describes the procedures to be used for labeling sample containers. Sample labels are used to document the sample identification number (ID), date, time, analysis to be performed, preservative, matrix, and sampler. A sample label will be attached to each sample container.

### **2.0 FIELD FORMS, SUPPLIES, AND EQUIPMENT**

**Writing utensil (preferably black pen with indelible ink)**

**Disposable medical-grade gloves (e.g. latex, nitrile)**

**Sample log sheets**

**Required sample containers:** All sample containers for analysis by fix-based laboratories will be supplied and deemed certified-clean by the laboratory.

**Sample labels**

**Sealable polyethylene bags**

**Heavy-duty cooler**

**Ice**

### **3.0 PROCEDURES**

3.1 The following information will be electronically printed on each sample label prior to mobilizing for field activities. Additional "generic" labels will also be available prior to mobilization to be used for field QC and backups.

- Project Name
- Project Number and Contract Task Order Number (CTO WE01)
- Sample ID
- Preservative
- Analysis to be Performed



- 3.2 Select the container(s) that are appropriate for a given sample. Fill the containers with sample material. Securely close the container lids without over tightening. Clean and dry bottle/jar as needed.
- 3.3 Select the sample-specific ID label(s), complete date, time, and sampler name, and affix to the sample container(s).
3. Place the sample container in a sealable polyethylene bag and place in a cooler containing ice.

Example of a sample label is attached at the end of this SOP.

#### 4.0 ATTACHMENTS

##### ATTACHMENT 1 SAMPLE LABEL



**TETRA TECH** *NCBC Davisville, RI; CED Area  
112G01813.XXXX WE01*

Sample ID: MW03-02-080114

Sampled by:

Date:

Time:

Analysis: VOC 8260B

Preservative: HCL,  $\leq 6^{\circ}\text{C}$

## **STANDARD OPERATING PROCEDURE**

### **SOP-03**

## **SAMPLE IDENTIFICATION NOMENCLATURE**

### **1.0 PURPOSE**

The purpose of this Standard Operating Procedure (SOP) is to establish a consistent sample nomenclature system that will facilitate subsequent data management. The sample nomenclature system has been devised such that the following objectives can be attained.

- Sorting of data by site, location, or matrix
- Maintenance of consistency (field, laboratory, and database sample numbers)
- Accommodation of all project-specific requirements
- Accommodation of laboratory sample number length constraints
- Ease of sample identification

### **2.0 REQUIRED FIELD FORMS AND EQUIPMENT**

**Writing utensil (preferably black pen with indelible ink)**

**Sample container labels**

**Sample form**

### **3.0 SAMPLE IDENTIFICATION NOMENCLATURE**

#### **3.1 Environmental Samples**

All environmental samples will be properly labeled with a sample label affixed to the sample container. Each sample will be assigned a unique sample tracking number.

##### **3.1.1 Environmental Sample Numbering Scheme**

The sample tracking number will consist of a four- or five-segment alpha-numeric code that identifies the sample's associated Site number (Site 03), sample type, location, and sample depth. For soil samples, the final four tracking numbers will identify the depth in units of feet below ground surface (bgs) at which the sample was collected (rounded to the nearest foot). For groundwater samples, the final 6 tracking

numbers will show the date that the sample was collected. Sample Identifications are summarized in Table 8-1 in the SAP.

For soil samples, the alphanumeric coding to be used is explained in the following diagram and subsequent definitions:

<b>NN</b>	<b>AA</b>	<b>NNN</b>	<b>NNNN</b>
Site Number	Matrix	Sample Location Number	Sequential depth interval from freshly exposed surface

**Character Type:**

A = Alpha  
 N = Numeric

**Site Number (NN):**

03 = Site 03

**Matrix Code (AA):**

SS = Surface Soil Sample  
 SB = Subsurface Soil Sample

**Location Number (NNN):**

Sequential number beginning with "001" for each matrix.

**Depth Interval (NNNN):**

This code section will be used for soil samples only. The depth code is used to note the depth below ground surface (bgs) at which a soil or sediment sample is collected. The first two numbers of the four-number code specify the top interval, and the third and fourth numbers specify the bottom interval of the sample depth. The depths will be noted in whole numbers only; further detail, if needed, will be recorded on the sample log sheet, boring log, logbook, etc.

For soil samples, the final four tracking numbers will identify the depth in units of feet. Surface soil samples will be collected from 0 to 2 feet bgs. Subsurface soil samples will be collected at depths greater than 2 feet bgs.

Examples:

1. 03SS023-0002 = surface soil sample from Site 03 at location 023 at a depth of 0-2 ft.
2. 03SB028-0406 = subsurface soil sample from Site 03 at location 028 at a depth of 4-6 ft.

For groundwater samples, the alphanumeric coding to be used is explained in the following diagram and subsequent definitions:

	<b>NNA-</b>	<b>AAA-</b>	<b>NNNNNN</b>
	Well Number	Matrix Designator	Sample Date and Event Designator

**Character Type:**

A = Alpha  
 N = Numeric

**Well Number (NNA):**

NN = Well Number  
 A = Depth Designator

**Matrix Designator (AAA):**

All groundwater samples will be designated with "NWG".

**Sample Date (NNNNNN):**

This six-number code specifies the date of the groundwater sample collected.

Examples:

MW03-02S-080814 = groundwater sample collected from Site 03 at well 02S on August 8, 2014.

MW02-02S-080814 = groundwater sample collected from Site 02 at well 02S on August 8, 2014.

### **3.2      Field Quality Assurance/Quality Control (QA/QC) Sample Nomenclature**

Field QA/QC samples are described in the UFP-SAP. They will be designated using a different coding system than the one used for regular field samples.

#### **3.2.1      QC Sample Numbering**

The QC code will consist of a four-segment alpha-numeric code that identifies the sample QC type, the date the sample was collected, and the number of this type of QC sample collected on that date.

<b>AA</b>	<b>NN</b>	<b>NNNNNN</b>
QC Type	Sequence Number (per day)	Date

The QC types are identified as:

TB = Trip Blank

RB = Rinsate Blank

FD = Field Duplicate

The sampling time recorded on the Chain-of-Custody Form, labels, and tags for duplicate samples will be "0000" so that the samples are "blind" to the laboratory. Notes detailing the sample number, time, date, and type will be recorded on the sample log sheets and will document the location of the duplicate sample (sample log sheets are not provided to the laboratory).

Example:

TB01-080814 = First trip blank on August 8, 2014.

FD02-080814 = second duplicate sample on August 8, 2014.

## **STANDARD OPERATING PROCEDURE**

### **SOP-04**

## **SAMPLE CUSTODY AND DOCUMENTATION OF FIELD ACTIVITIES**

### **1.0 PURPOSE**

This Standard Operating Procedure (SOP) establishes the procedures for sample custody and documentation of field sampling and field analyses activities.

### **2.0 FIELD FORMS, SUPPLIES, AND EQUIPMENT**

**Writing utensil (preferably black pen with indelible ink)**

**Site logbook**

**Sample labels**

**Chain-of-Custody Form**

**Custody seals**

**Equipment calibration log**

**Soil Boring Log**

**Soil and Sediment Sample Log Sheet**

### **3.0 PROCEDURES**

This section describes custody and documentation procedures. All entries made into the logbooks, custody documents, logbooks, and log sheets described in this SOP must be made in indelible ink (black is preferred). No erasures are permitted. If an incorrect entry is made, the entry will be crossed out with a single strike mark, initialed, and dated.

#### **3.1 Site Logbook**

The site logbook is a hard-bound, paginated, controlled-distribution record book in which all major on-site activities are documented. At a minimum, the following activities and events will be recorded (daily) in the site logbook:

- All field personnel present

- Arrival/departure of site visitors
- Arrival/departure of equipment
- Start or completion of sampling activities
- Daily on-site activities
- Sample pickup information
- Health and safety issues
- Weather conditions

The site logbook is initiated at the start of the first on-site activity (e.g., site visit or initial reconnaissance survey). Entries are to be made for every day that on-site activities take place.

The following information must be recorded on the cover of each site logbook:

- Project name
- Project number
- Book number
- Start date
- End date

Information recorded daily in the site logbook need not be duplicated in other field notebooks but must summarize the contents of these other notebooks and refer to specific page locations in these notebooks for detailed information (where applicable). At the completion of each day's entries, the site logbook must be signed and dated by the Tetra Tech Field Operations Leader (FOL).

### **3.2 Field Logbooks**

The field logbook is a separate, dedicated notebook used by field personnel to document his or her activities in the field. This notebook is hardbound and paginated. At a minimum, the following activities and events will be recorded (daily) in the field logbooks:

- Field personnel for activities in the field logbook
- Arrival/departure of site visitors
- Arrival/departure of equipment
- Start or completion of sampling activities
- Daily on-site activities performed each day

- Sample pickup information
- Health and safety issues
- Weather conditions

Entries are to be made for every day that on-site activities take place.

The following information must be recorded on the cover of each field logbook:

- Project name
- Project number
- Book number
- Start date
- End date

### **3.3 Sample Labels**

Adhesive sample container labels must be completed and applied to every sample container. Sample labeling and nomenclature are described in SOP-01 and SOP-02, respectively.

### **3.4 Chain-of-Custody Form**

The Chain-of-Custody Form (COC) is a multi-part form that is initiated as samples are acquired and accompanies a sample (or group of samples) as it is transferred from person to person. This form must accompany any samples collected for laboratory chemical analysis. Each COC will be uniquely numbered. A copy of a blank COC form is attached at the end of this SOP.

The FOL must include the name of the laboratory in the upper right hand corner section to ensure that the samples are forwarded to the correct location. If more than one COC is necessary for any cooler, the FOL will indicate "Page \_\_\_ of \_\_\_" on each COC. The original (top) signed copy of the COC will be placed inside a sealable polyethylene bag and taped inside the lid of the shipping cooler. Once the samples are received at the laboratory, the sample custodian checks the contents of the cooler(s) against the enclosed COC(s). Any problems are noted on the enclosed COC Form (bottle breakage, discrepancies between the sample labels, COC form, etc.) and will be resolved through communication between the laboratory point-of-contact and the Tetra Tech Project Manager (PM). The COC form is signed and retained by the laboratory and becomes part of the sample's corresponding analytical data package.



### **3.5 Custody Seal**

The custody seal is an adhesive-backed label and is part of the chain-of-custody process. Custody seals are used to prevent tampering with samples after they have been collected in the field and sealed in coolers for transit to the laboratory. Custody seals will be signed and dated by the samplers and affixed across the opening edges of each cooler (two seals per cooler on opposite sides) containing environmental samples. The laboratory sample custodian will examine the custody seal for evidence of tampering and will notify the Tetra Tech PM if evidence of tampering is observed.

### **3.6 Equipment Calibration Log**

The Equipment Calibration Log is used to document calibration of measuring equipment used in the field. The Equipment Calibration Log documents that the manufacturer's instructions were followed for calibration of the equipment, including frequency and type of standard or calibration device. An Equipment Calibration Log must be maintained for each electronic measuring device requiring calibration. Entries must be made for each day the equipment is used.

### **3.7 Sample Log Sheets**

The following Log Sheets are used to document the development of groundwater monitoring wells and the sampling of soil, groundwater, sediment, and surface water. Copies of the sample log sheets are attached at the end of the SOP. A sample log sheet will be prepared for each sample collected and submitted for laboratory analysis.

## **4.0 ATTACHMENTS**

1. Chain-of-Custody Record
2. Equipment Calibration Log
3. Soil and Sediment Sample Log
4. Surface Water Sample Log
5. Soil Boring Log
6. Well Development Log
7. Groundwater Sampling Form

NUMBER

PAGE \_\_\_\_ OF \_\_\_\_

[illegible]

DISTRIBUTION: WHITE (ACCOMPANIES SAMPLE)

YELLOW (FIELD COPY)

PINK (FILE COPY)

3/99  
FORM NO. TtNUS-001

**ATTACHMENT 1**  
**CHAIN-OF-CUSTODY RECORD**

## EQUIPMENT CALIBRATION LOG

PROJECT NAME : \_\_\_\_\_

INSTRUMENT NAME/MODEL: \_\_\_\_\_

SITE NAME: \_\_\_\_\_

MANUFACTURER: \_\_\_\_\_

PROJECT No.: \_\_\_\_\_

SERIAL NUMBER: \_\_\_\_\_

[illegible]

## ATTACHMENT 2

### EQUIPMENT CALIBRATION LOG

Project Site Name:		Sample ID No.:	
Project No.:		Sample Location:	
<input type="checkbox"/> Surface Soil		Sampled By:	
<input type="checkbox"/> Subsurface Soil		C.O.C. No.:	
<input type="checkbox"/> Sediment		Type of Sample:	
<input type="checkbox"/> Other:		<input type="checkbox"/> Low Concentration	
<input type="checkbox"/> QA Sample Type:		<input type="checkbox"/> High Concentration	

  
**GRAB SAMPLE DATA:**

Date:	Depth Interval	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Time:			
Method:			
Monitor Reading (ppm):			

  
**COMPOSITE SAMPLE DATA:**

Date:	Time	Depth Interval	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Method:				
Monitor Readings (Range in ppm):				

  
**SAMPLE COLLECTION INFORMATION:**

Analysis	Container Requirements	Collected	Other

  
**OBSERVATIONS / NOTES:**      **MAP:**

--	--

  
**Circle if Applicable:**      **Signature(s):**

MS/MSD	Duplicate ID No.:
--------	-------------------

## SURFACE WATER SAMPLE LOG SHEET



## SURFACE WATER SAMPLE LOG SHEET

Page \_\_\_\_ of \_\_\_\_

[illegible]





## Page \_\_\_\_ of \_\_\_\_

Well: \_\_\_\_\_ Depth to Bottom (ft.): \_\_\_\_\_ Responsible Personnel: \_\_\_\_\_  
 Site: \_\_\_\_\_ Static Water Level Before (ft.): \_\_\_\_\_ Drilling Company: \_\_\_\_\_  
 Date Installed: \_\_\_\_\_ Static Water Level After (ft.): \_\_\_\_\_ Project Name: \_\_\_\_\_  
 Date Developed: \_\_\_\_\_ Screen Length (ft.): \_\_\_\_\_ Project Number: \_\_\_\_\_  
 Dev. Method: \_\_\_\_\_ One Well Volume (gal/L): \_\_\_\_\_ PID Readings: Bore Hole \_\_\_\_\_ ppm  
 Pump Type: \_\_\_\_\_ Casing ID (in.): \_\_\_\_\_ PID Readings: Breathing Zone \_\_\_\_\_ ppm

[illegible]

ATTACHMENT 6  
WELL DEVELOPMENT LOG

NCBC Davisville  
UFP-SAP for CED Area Site 03  
Revision: 0  
Date: April 2014  
SOP-04 Page 10 of 11



Site Name: CED AREA, North Kingston, RI  
Sample ID: MW0 -

Tetra Tech NUS Charge No. 112G01813. / CTO WE01 Page 1 of  
QC: (If applicable)

Sample Method: Low Stress (flow) with Peristaltic Pump  
 Depth Sampled: \_\_\_\_\_ ft bgs      Screen Int. Depth \_\_\_\_\_ ft bgs  
 Sample Date & Time: \_\_\_\_/\_\_\_\_/2008 \_\_\_\_\_ hours \_\_\_\_\_ (Dup Time)  
 Sampler(s): \_\_\_\_\_  
 Data Recorded By: \_\_\_\_\_ Signature: \_\_\_\_\_  
 Well Diameter/Total Depth \_\_\_\_\_ (ft below TOR); Stickup \_\_\_\_\_  
 Visual Evidence of Sheen (Yes/No) \_\_\_\_\_  
 Olfactory Evidence of Odor (Yes/No) \_\_\_\_\_  
 Weather: \_\_\_\_\_

PID	BZ	/ W=	/ PW=	PPM	Field Instrument Group A/B/C/D
Pre-tubing insertion WL	_____ ft btor;		Post tubing insertion WL	_____ ft btor	
Analyte	Preservative	Container requirements	Collected		

Analyte	Preservative	Container requirements	Collected
VOC	4°C, HCL	3 x 40 mL vial with HCL	Yes / No
SVOC	4°C	2 x 1 liter amber glass	Yes / No
PAH	4°C	2 x 1 liter amber glass	Yes / No
Pesticides	4°C	2 x 1 liter amber glass	Yes / No
PCB	4°C	2 x 1 liter amber glass	Yes / No
Metals (filtered/unfiltered)	4°C, HNO <sub>3</sub>	1 x 2 500 mL poly with HNO <sub>3</sub>	Yes / No
Salinity	4°C	1 x 1 250mL poly	Yes / No

[illegible]

TtNUS Form 0009 (modified)

Well or Saturated Screen Volume (gallons) \_\_\_\_\_. 2in Screen Volume = 0.163 gal/ft or 616 ml per foot.  
 BZ=Breathing Zone, W=Well, PW=Purge Water

1. Pump dial setting (for example: hertz, cycle/min, etc.)
2. Siemens per cm (same as umhos/cm) at 25 °C.
3. Oxidation reduction potential (stand in for Eh).

ATTACHMENT 7  
GROUNDWATER SAMPLING FORM

NCBC Davisville  
UFP-SAP for CED Area Site 03  
Revision: 0  
Date: April 2014  
SOP-04 Page 11 of 11



## STANDARD OPERATING PROCEDURE

### SOP-05

## SAMPLE PRESERVATION, PACKAGING, AND SHIPPING

### 1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the procedures for sample preservation, packaging, and shipping to be used in handling soil, sediment, and aqueous samples.

### 2.0 FIELD FORMS, SUPPLIES, AND EQUIPMENT

**Shipping labels**

**Custody seals**

**Chain-of-custody (COC) form(s)**

**Sample containers with preservatives:** All sample containers for analysis by fixed-base laboratories will be supplied, with preservatives added (if required) and deemed certified clean by the laboratory.

**Sample shipping containers (coolers):** All sample shipping containers are supplied by the laboratory.

**Packaging material:** Bubble wrap, sealable polyethylene bags, strapping tape, etc.

### 3.0 PROCEDURES FOR SAMPLE PRESERVATION, PACKAGING, AND SHIPPING

- 3.1 The laboratory provides sample containers with preservative already included (as required) for the analytical parameter for which the sample is to be analyzed. All samples will be held, stored, and shipped  $\leq 6$  degrees Celsius ( $^{\circ}\text{C}$ ). This will be accomplished through refrigeration (used to hold samples prior to shipment) and/or ice.
- 3.2 The sampler shall maintain custody of the samples until the samples are relinquished to another custodian or to the common carrier.
- 3.3 Check that each sample container is properly labeled, the container lid is securely fastened, and the container is sealed in a polyethylene bag.
- 3.4 If the container is glass, place the sample container into a bubble-out shipping bag and seal the bag using the self-sealing tape supplied with the bag.

- 3.5 Inspect the insulated shipping cooler. Check for any cracks, holes, broken handles, etc. If the cooler has a drain plug, make certain it is sealed shut with duct tape on the outside of the cooler. If the cooler is questionable for shipping, the cooler must be discarded.
- 3.6 Line the bottom of the cooler with a layer of bubble wrap then line the cooler with large plastic bag.. Place the sample containers into the bag within the shipping cooler in an upright position (containers will be upright, with the exception of any 40-milliliter vials). Continue filling the cooler with ice until the cooler is nearly full and the movement of the sample containers is limited.
- 3.7 Wrap the large plastic bag closed and secure with tape.
- 3.8 Place the original (top) signed copy of the COC form inside a sealable polyethylene bag. Tape the bag to the inside of the lid of the shipping cooler. The cooler is ready for laboratory pickup.

For samples that are to be shipped, the following procedures shall be followed:

- Close the cooler and seal the cooler with approximately four wraps of strapping tape at each end of the cooler. Prior to wrapping the last wrap of strapping tape, apply a signed and dated custody seal to each side of the cooler (one per side). Cover the custody seal with the last wrap of tape. This will provide a tamper evident custody seal system for the sample shipment.
- Affix shipping labels to each of the coolers, ensuring all of the shipping information is filled in properly. Overnight (e.g., FedEx Priority Overnight) courier services will be used for all sample shipments.
- All samples will be shipped to the laboratory no more than 72 hours after collection. Under no circumstances should sample hold times be exceeded.

## **STANDARD OPERATING PROCEDURE**

### **SOP-06**

## **BOREHOLE ADVANCEMENT AND SOIL CORING USING DIRECT-PUSH TECHNOLOGY AND HAND AUGER TECHNIQUES**

### **1.0 PURPOSE**

This Standard Operating Procedure (SOP) describes the procedures for collecting surface and subsurface soil cores from unconsolidated overburden materials using direct-push technology (DPT) and hand augering techniques.

### **2.0 FIELD FORMS AND EQUIPMENT**

**Disposable medical-grade gloves (e.g., latex, nitrile)**

**Writing utensil**

**Boring log sheets:** A copy of this form is included in SOP-07.

Stainless steel bowl and spoon (or disposable scoop)

Sample jars and bottle labels

**DPT Equipment (to be supplied by the drilling subcontractor):**

**DPT Probe Rig**

**Geoprobe® Macrocore Sampler or equivalent**

**Geoprobe® Sampling Kit or equivalent**

**Clear acetate liners:** one new liner for each soil core

**Bentonite pellets and clean sand**

**Hand Auger Equipment:**

**Stainless Steel Auger Buckets**

**Stainless Steel Extension Rods**

**Cross Handle**

**Required decontamination materials** (see SOP-12)

### **3.0 BOREHOLE ADVANCEMENT AND SOIL SAMPLING USING A DPT**

DPT will be employed to collect soil cores. DPT refers to sampling tools and sensors that are driven directly into the ground without the use of conventional rotary drilling equipment. DPT typically utilizes

hydraulic pressure and/or percussion hammers to advance the sampling tools. Geoprobe® is a manufacturer of a hydraulically powered, percussion/probing machine utilizing DPT to collect subsurface environmental samples.

- 3.1 Clear the area to be sampled of any surface debris (vegetation, twigs, rocks, litter, etc.).
- 3.2 The driller and/or helper will place a new clear acetate liner in the detachable sampling core barrel, and attach the coring device to the DPT rig.
- 3.3 The driller and/or helper will drive the sampler (lined with an acetate sleeve) into the ground to the desired depth using hydraulic pressure.
- 3.4 The driller and/or helper will retract the sampler from the borehole, and remove the acetate liner and the soil core from the sampler barrel.
- 3.5 The driller and/or helper will attach the metal trough from the sampling kit firmly to a suitable surface.
- 3.6 The driller and/or helper will place the acetate liner containing the soil core in the trough.
- 3.7 While wearing cut-resistant gloves (constructed of non-latex over cotton), the driller and/or helper will cut the acetate liner through its entire length on two sides using the hooked knife that accompanies the Geoprobe® Sampling Kit. Then remove the strip of acetate from the trough to gain access to the collected soils. **CAUTION:** Do not attempt to cut the acetate liner while holding the acetate sleeve in your hand.
- 3.8 Log the soil core on the Boring Log Sheet (see SOP-07).
- 3.9 Place the soil core in a stainless-steel mixing bowl, thoroughly homogenize, and collect the remainder of the soil sample aliquots, as described in SOP-08.
- 3.10 Repeat steps 3.2 through 3.09 for the next depth intervals.
- 3.11 Upon completion of the boring, backfill the borehole with the soil from the location. If insufficient soil is available to fill the hole to the ground surface, then bentonite pellets mixed with the soil will be used to backfill the hole to 1 ft. bgs, then clean sand to grade. If soil materials from the boring

are suspected of being impacted by contamination based upon visual and olfactory observations, the soil boring will be backfilled with bentonite pellets up to 1 ft. bgs then clean sand to the ground surface. The contaminated material will be securely staged in labeled drums in the IDW staging area until arrangements are made for proper off-site disposal.

- 3.12 Decontaminate all soil sampling equipment in accordance with SOP-14 before collecting the next sample.

#### **4.0 BOREHOLE ADVANCEMENT AND SOIL SAMPLING USING A HAND AUGER**

Hand augers may be employed to collect soil cores when the area is inaccessible by the drill rig. A hand augering system generally consists of a variety of all stainless steel bucket bits (i.e. cylinders 6-1/2" long and 2-3/4", 3-1/4", and 4" in diameter), a series of extension rods (available in 2', 3', 4' and 5' lengths), a cross handle. A larger diameter bucket bit is commonly used to bore a hole to the desired sampling depth and then withdrawn. In turn, the larger diameter bit is replaced with a smaller diameter bit, lowered down the hole, and slowly turned into the soil at the completion depth or refusal. The apparatus is then withdrawn and the soil sample collected.

The hand auger can be used in a wide variety of soil conditions. It can be used to sample soil, both from the surface, or to depths in excess of 12 feet. However, the presence of rock layers and the collapse of the borehole normally contribute to its limiting factors.

- 4.1 Attach a properly decontaminated stainless steel auger bucket bit into a clean extension rod and further attach the cross handle to the extension rod.
- 4.2 Clear the area to be sampled of any surface debris (vegetation, twigs, rocks, litter, etc.)
- 4.3 Begin augering to the desired sample depth (periodically removing accumulated soils from the bucket bit into a properly decontaminated stainless steel mixing bowl if that soil is needed for sampling, otherwise stage the extra soil on poly), and add additional rod extensions as necessary. Discard the top of the core (approximately 1"), which represents any loose material collected by the bucket bit before penetrating the sample material.
- 4.4 Log the soil core each time soil is placed into the mixing bowl or poly on the Boring Log Sheet (see SOP-07). Also, note on the boring log the changes in the color, texture or odor of the soil.

- 4.5 After reaching the desired sample depth, slowly and carefully withdraw the apparatus from the borehole.
- 4.6 Utilizing a properly decontaminated stainless steel trowel or disposable trowel, remove the last of the sample material from the bucket bit and place into the properly decontaminated stainless steel mixing bowl. If grab samples are required, take them before you thoroughly homogenize the sample material. Once the samples are ready, begin filling the sample containers, as described in SOP-08.
- 4.7 Excess clean soil core materials will be returned to the hole and tamped (see step 4.8 and 4.9 for contaminated soil). If insufficient soil is available to fill the hole to the ground surface, then bentonite pellets mixed with the soil will be used to backfill the hole to 1 ft. bgs, then the remainder of the borehole will be backfilled with clean sand.
- 4.8 If the soil appears contaminated based upon visual or olfactory observations, excess soil core materials will be placed in a labeled 55-gallon drum in the IDW staging area.
- 4.9 If soil materials from the boring are suspected of being contaminated, the soil boring will be backfilled with bentonite pellets up to 1 ft. bgs then clean sand to the ground surface.
- 4.10 Decontaminate all soil sampling equipment in accordance with SOP-14 before collecting the next sample.



**TETRA TECH**

# STANDARD OPERATING PROCEDURES

Number **SOP-07**  
**GH-1.5**

Page  
1 of 20

Effective Date  
01/2012

Revision  
2

Applicability  
Tetra Tech, Inc.

Prepared  
Earth Sciences Department

Subject  
**BOREHOLE AND SAMPLE LOGGING**

Approved  
J. Zimmerly

## TABLE OF CONTENTS

<b><u>SECTION</u></b>	<b><u>PAGE</u></b>
<b>1.0 PURPOSE.....</b>	<b>3</b>
<b>2.0 SCOPE.....</b>	<b>3</b>
<b>3.0 GLOSSARY .....</b>	<b>3</b>
<b>4.0 RESPONSIBILITIES .....</b>	<b>3</b>
<b>5.0 PROCEDURES .....</b>	<b>3</b>
5.1 MATERIALS NEEDED.....	3
5.2 CLASSIFICATION OF SOILS .....	3
5.2.1 USCS Classification .....	6
5.2.2 Color .....	6
5.2.3 Relative Density and Consistency .....	6
5.2.4 Weight Percentages .....	7
5.2.5 Moisture.....	10
5.2.6 Stratification .....	10
5.2.7 Texture/Fabric/Bedding .....	10
5.2.8 Summary of Soil Classification.....	10
5.3 CLASSIFICATION OF ROCKS.....	13
5.3.1 Rock Type .....	13
5.3.2 Color .....	16
5.3.3 Bedding Thickness.....	16
5.3.4 Hardness .....	16
5.3.5 Fracturing .....	16
5.3.6 Weathering.....	17
5.3.7 Other Characteristics .....	17
5.3.8 Additional Terms Used in the Description of Rock.....	18
5.4 ABBREVIATIONS .....	19
5.5 BORING LOGS AND DOCUMENTATION .....	19
5.5.1 Soil Classification .....	19
5.5.2 Rock Classification .....	23
5.5.3 Classification of Soil and Rock from Drill Cuttings .....	24
5.6 REVIEW .....	24
<b>6.0 REFERENCES.....</b>	<b>24</b>
<b>7.0 RECORDS .....</b>	<b>25</b>

Subject  BOREHOLE AND SAMPLE LOGGING	Number GH-1.5	Page 2 of 20
	Revision 2	Effective Date 01/2012

## TABLE OF CONTENTS (Continued)

### FIGURES

<u>NUMBERS</u>		<u>PAGE</u>
1	BORING LOG (EXAMPLE) .....	4
2	CONSISTENCY FOR COHESIVE SOILS .....	8
3	BEDDING THICKNESS CLASSIFICATION .....	10
4	GRAIN SIZE CLASSIFICATION FOR ROCKS.....	12
5	COMPLETED BORING LOG (EXAMPLE) .....	17



Subject  BOREHOLE AND SAMPLE LOGGING	Number GH-1.5	Page 3 of 20
	Revision 2	Effective Date 01/2012

## 1.0 PURPOSE

The purpose of this document is to establish standard procedures and technical guidance on borehole and sample logging.

## 2.0 SCOPE

These procedures provide descriptions of the standard techniques for borehole and sample logging. These techniques shall be used for each boring logged to provide consistent descriptions of subsurface lithology. While experience is the only method to develop confidence and accuracy in the description of soil and rock, the field geologist/engineer can do a good job of classification by careful, thoughtful observation and by being consistent throughout the classification procedure.

## 3.0 GLOSSARY

None.

## 4.0 RESPONSIBILITIES

Site Geologist. Responsible for supervising all boring activities and assuring that each borehole is completely logged. If more than one rig is being used on site, the Site Geologist must make sure that each field geologist is properly trained in logging procedures. A brief review or training session may be necessary prior to the start up of the field program and/or upon completion of the first boring.

## 5.0 PROCEDURES

The classification of soil and rocks is one of the most important jobs of the field geologist/engineer. To maintain a consistent flow of information, it is imperative that the field geologist/engineer understand and accurately use the field classification system described in this SOP. This identification is based on visual examination and manual tests.

### 5.1 Materials Needed

When logging soil and rock samples, the geologist or engineer may be equipped with the following:

- Rock hammer
- Knife
- Camera
- Dilute hydrochloric acid (HCl)
- Ruler (marked in tenths and hundredths of feet)
- Hand Lens

### 5.2 Classification of Soils

All data shall be written directly on the boring log (Figure 1) or in a field notebook if more space is needed. Details on filling out the boring log are discussed in Section 5.5.

**FIGURE 1**  
**BORING LOG (EXAMPLE)**



## BORING LOG

Page \_\_\_\_ of \_\_\_\_

PROJECT NAME:  
PROJECT NUMBER:  
DRILLING COMPANY:  
DRILLING RIG:

BORING NUMBER: 1

DATE:

**GEOLOGIST:**

DRILLER:

[illegible]

\* When rock coring, enter rock brokenness.

\*\* Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated response read.

Remarks:

### Drilling Area

Background (ppm):

Converted to Well:

Yes

No

Well I.D. #:

FIGURE 1 (CONTINUED)

## SOIL TERMS

UNIFIED SOIL CLASSIFICATION (USCS)										
COARSE-GRAINED SOILS More Than Half of Material is LARGER Than No. 200 Sieve Size					FINE-GRAINED SOILS More Than Half of Material is SMALLER Than No. 200 Sieve Size					
FIELD IDENTIFICATION PROCEDURES (Excluding Field Soil Layer Thin > 1 inches and Shelby Fracture on Estimated Heights)			GROUP SYMBOL	TYPICAL NAMES	FIELD IDENTIFICATION PROCEDURES (Excluding Field Soil Layer Thin > 1 inches and Shelby Fracture on Estimated Heights)			GROUP SYMBOL	TYPICAL NAMES	
					Identification Procedure on Fracture Smaller Than No. 4 Sieve Size					
					DEVELOPMENT OF SHEARING CHARACTERISTICS	DEVELOPMENT OF SHEARING CHARACTERISTICS	TOUCH TESTS (Consistency Near Plastic Limit)			
GRAVELS (G) > 40% SWP	CLEAN GRAVELS (L) > 40% (Flow)	One range in grain size and substantial amounts of all intermediate gradations.	GC	Uniformly graded gravels, gravel-sand mixtures, little or no fines.	SILTS AND CLAYS (Liquid Limit < 4)	None to Slight	Out to Flow	None	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity.
		Preferentially one size or a range of sizes with some intermediate size continuity.	GP	Poorly graded gravels, gravel-sand mixtures, little or no fines.		Medium to High	None to Very Slow	Medium	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
	GRAVELS (F) FES (High Water)	Non-plastic: (See Identification procedures, see ML)	GM	Silty gravels, poorly graded sand-silt mixtures.		Slight to Medium	Slow	Slight	OL	Organic clays of low plasticity.
		Plastic: (See Identification procedures, see CL)	GO	Clayey gravels, poorly graded gravel-sand mixtures.	SILTS AND CLAYS (Liquid Limit < 4)	Slight to Medium	Shrink None	Slight to Medium	MH	Inorganic clays of medium to high plasticity, gravelly clays, sandy clays, silty clays, lean clays.
SANDS (S) > 40% SWP	CLEAN SANDS (L) > 40% (Flow)	One range in grain size and substantial amounts of all intermediate gradations.	SC	Uniformly graded sands, gravelly sands, little or no fines.		High to Very High	None	High	OH	Inorganic clays of high plasticity, fat clays.
		Preferentially one size or a range of sizes with some intermediate size continuity.	SP	Poorly graded sands, gravelly sands, little or no fines.		Medium to High	None to Very Slow	Slight to Medium	OH	Organic clays of medium to high plasticity.
	SANDS (F) FES (High Water)	Non-plastic: (See Identification procedures, see ML)	SM	Silty sands, poorly graded sand-silt mixtures.	HIGHLY ORGANIC SOILS	Readily disintegrated by color, odor, spongy feel and frequently by thumb test.			PT	Peat and other organic soils.
		Plastic: (See Identification procedures, see CL)	SD	Clayey sands, poorly graded sand-clay mixtures.						

Boundary classification: Soils possessing characteristics of two groups are designated by combining group symbols. For example, GC/SC, well graded gravel-sand mixture with clay binder.

All test sizes on this chart are U.S. Standard.

DENSITY OF GRANULAR SOILS	
DESIGNATION	STANDARD PENETRATION RESISTANCE - BLOOMSBOTTOM
Very Loose	< 4
Loose	4 - 9
Medium Loose	10 - 19
Dense	20 - 29
Very Dense	Over 30

CONSISTENCY OF COHESIVE SOILS			
CONSISTENCY	UNID. COMPRESSION STRESS (TONS/SQ. FT.)	STANDARD PENETRATION RESISTANCE - BLOOMSBOTTOM	FIELD IDENTIFICATION NOTES
Very Soft	Less than 0.5	< 1 to 2	Easily penetrated several inches by fist.
Soft	0.5 to 1.0	2 to 4	Easily penetrated several inches by thumb.
Medium Soft	1.0 to 1.5	4 to 6	Can be penetrated several inches by thumb.
Stiff	1.5 to 2.0	6 to 8	Readily indented by thumb.
Very Stiff	2.0 to 4.0	8 to 12	Readily indented by thumbnail.
Hard	More than 4.0	Over 12	Indented with difficulty by thumbnail.

## ROCK TERMS

ROCK HARDNESS (FROM CORE SAMPLES)			ROCK BROKENNESS		
Descriptive Term	Scratch or Knife Tests	Hammer Tests	Descriptive Term	Abbreviation	Spacing
Soft	Easily Scratched	Crumbles when pressed with hammer	Very Broken	(V.B.)	< 4"
Medium Soft	Can be Scratched	Breaks into blocks, crumbly edges	Broken	(B.)	4" - 7"
Medium Hard	Can be Scratched	Breaks into blocks, sharp edges	Blocky	(Bk.)	7" - 9"
Hard	Cannot be Scratched	Breaks into blocks, sharp edges	Massive	(M.)	> 9"

LEGEND:

SOIL SAMPLES - TYPES

1-4" Split Barrel Sample

8" x 10" O.D. Undisturbed Sample

0 - Other Samples, Specify in Remarks

ROCK SAMPLES - TYPES

XNO (Conventional) Core (1-14" O.D.)

GNO (Standard) Core (1-14" O.D.)

Z - Other Core Sizes, Specify in Remarks

CORE LEVELS

1-2'

Initial Load outside of depth

1-2'

Stabilized Load outside of depth

Subject

BOREHOLE AND SAMPLE LOGGING

Number

GH-1.5

Page

5 of 20

Revision

2

Effective Date

01/2012

Subject  BOREHOLE AND SAMPLE LOGGING	Number GH-1.5	Page 6 of 20
	Revision 2	Effective Date 01/2012

### 5.2.1 USCS Classification

Soils are to be classified according to the Unified Soil Classification System (USCS). This method of classification is detailed in Figure 1 (Continued).

This method of classification identifies soil types on the basis of grain size and cohesiveness.

Fine-grained soils, or fines, are smaller than the No. 200 sieve and are of two types: silt (M) and clay (C). Some classification systems define size ranges for these soil particles, but for field classification purposes, they are identified by their respective behaviors. Organic material (O) is a common component of soil but has no size range; it is recognized by its composition. The careful study of the USCS will aid in developing the competence and consistency necessary for the classification of soils.

Coarse-grained soils shall be divided into rock fragments, sand, or gravel. The terms sand and gravel not only refer to the size of the soil particles but also to their depositional history. To insure accuracy in description, the term rock fragments shall be used to indicate angular granular materials resulting from the breakup of rock. The sharp edges typically observed indicate little or no transport from their source area, and therefore the term provides additional information in reconstructing the depositional environment of the soils encountered. When the term "rock fragments" is used it shall be followed by a size designation such as "(1/4 inch $\Phi$ -1/2 inch $\Phi$ )" or "coarse-sand size" either immediately after the entry or in the remarks column. The USCS classification would not be affected by this variation in terms.

### 5.2.2 Color

Soil colors shall be described utilizing a single color descriptor preceded, when necessary, by a modifier to denote variations in shade or color mixtures. A soil could therefore be referred to as "gray" or "light gray" or "blue-gray." Since color can be utilized in correlating units between sampling locations, it is important for color descriptions to be consistent from one boring to another.

Colors must be described while the sample is still moist. Soil samples shall be broken or split vertically to describe colors. Samplers tend to smear the sample surface creating color variations between the sample interior and exterior.

The term "mottled" shall be used to indicate soils irregularly marked with spots of different colors. Mottling in soils usually indicates poor aeration and lack of good drainage.

Soil Color Charts shall not be used unless specified by the project manager.

### 5.2.3 Relative Density and Consistency

To classify the relative density and/or consistency of a soil, the geologist is to first identify the soil type. Granular soils contain predominantly sands and gravels. They are noncohesive (particles do not adhere well when compressed). Finer-grained soils (silts and clays) are cohesive (particles will adhere together when compressed).

The density of noncohesive, granular soils is classified according to standard penetration resistances obtained from split-barrel sampling performed according to the methods detailed in Standard Operating Procedures GH-1.3 and SA-1.3. Those designations are:

Designation	Standard Penetration Resistance (Blows per Foot)
Very loose	0 to 4

Subject  BOREHOLE AND SAMPLE LOGGING	Number GH-1.5	Page 7 of 20
	Revision 2	Effective Date 01/2012

Loose	5 to 10
Medium dense	11 to 30
Dense	31 to 50
Very dense	Over 50

Standard penetration resistance is the number of blows required to drive a split-barrel sampler with a 2-inch outside diameter 12 inches into the material using a 140-pound hammer falling freely through 30 inches. The sampler is driven through an 18-inch sample interval, and the number of blows is recorded for each 6-inch increment. The density designation of granular soils is obtained by adding the number of blows required to penetrate the last 12 inches of each sample interval. It is important to note that if gravel or rock fragments are broken by the sampler or if rock fragments are lodged in the tip, the resulting blow count will be erroneously high, reflecting a higher density than actually exists. This shall be noted on the log and referenced to the sample number. Granular soils are given the USCS classifications GW, GP, GM, SW, SP, SM, GC, or SC (see Figure 1).

The consistency of cohesive soils is determined by performing field tests and identifying the consistency as shown in Figure 2.

Cohesive soils are given the USCS classifications ML, MH, CL, CH, OL, or OH (see Figure 1).

The consistency of cohesive soils is determined either by blow counts, a pocket penetrometer (values listed in the table as Unconfined Compressive Strength), or by hand by determining the resistance to penetration by the thumb. The pocket penetrometer and thumb determination methods are conducted on a selected sample of the soil, preferably the lowest 0.5 foot of the sample in the split-barrel sampler. The sample shall be broken in half and the thumb or penetrometer pushed into the end of the sample to determine the consistency. Do not determine consistency by attempting to penetrate a rock fragment. If the sample is decomposed rock, it is classified as a soft decomposed rock rather than a hard soil. Consistency shall not be determined solely by blow counts. One of the other methods shall be used in conjunction with it. The designations used to describe the consistency of cohesive soils are shown in Figure 2.

#### 5.2.4 Weight Percentages

In nature, soils are comprised of particles of varying size and shape, and are combinations of the various grain types. The following terms are useful in the description of soil:

Terms of Identifying Proportion of the Component	Defining Range of Percentages by Weight
Trace	0 - 10 percent
Some	11 - 30 percent
Adjective form of the soil type (e.g., "sandy")	31 - 50 percent

Subject  BOREHOLE AND SAMPLE LOGGING	Number GH-1.5	Page 8 of 20
	Revision 2	Effective Date 01/2012

## FIGURE 2

### CONSISTENCY FOR COHESIVE SOILS

Consistency	Standard Penetration Resistance (Blows per Foot)	Unconfined Compressive Strength (Tons/Sq. Foot by pocket penetration)	Field Identification
Very soft	0 to 2	Less than 0.25	Easily penetrated several inches by fist
Soft	2 to 4	0.25 to 0.50	Easily penetrated several inches by thumb
Medium stiff	4 to 8	0.50 to 1.0	Can be penetrated several inches by thumb with moderate effort
Stiff	8 to 15	1.0 to 2.0	Readily indented by thumb but penetrated only with great effort
Very stiff	15 to 30	2.0 to 4.0	Readily indented by thumbnail
Hard	Over 30	More than 4.0	Indented with difficulty by thumbnail

Subject  BOREHOLE AND SAMPLE LOGGING	Number GH-1.5	Page 9 of 20
	Revision 2	Effective Date 01/2012

Examples:

- Silty fine sand: 50 to 69 percent fine sand, 31 to 50 percent silt.
- Medium to coarse sand, some silt: 70 to 80 percent medium to coarse sand, 11 to 30 percent silt.
- Fine sandy silt, trace clay: 50 to 68 percent silt, 31 to 49 percent fine sand, 1 to 10 percent clay.
- Clayey silt, some coarse sand: 70 to 89 percent clayey silt, 11 to 30 percent coarse sand.

#### **5.2.5 Moisture**

Moisture content is estimated in the field according to four categories: dry, moist, wet, and saturated. In dry soil, there appears to be little or no water. Saturated samples obviously have all the water they can hold. Moist and wet classifications are somewhat subjective and often are determined by the individual's judgment. A suggested parameter for this would be calling a soil wet if rolling it in the hand or on a porous surface liberates water, i.e., dirties or muddies the surface. Whatever method is adopted for describing moisture, it is important that the method used by an individual remains consistent throughout an entire drilling job.

Laboratory tests for water content shall be performed if the natural water content is important.

#### **5.2.6 Stratification**

Stratification can only be determined after the sample barrel is opened. The stratification or bedding thickness for soil and rock is depending on grain size and composition. The classification to be used for stratification description is shown in Figure 3.

#### **5.2.7 Texture/Fabric/Bedding**

The texture/fabric/bedding of the soil shall be described. Texture is described as the relative angularity of the particles: rounded, subrounded, subangular, and angular. Fabric shall be noted as to whether the particles are flat or bulky and whether there is a particular relation between particles (i.e., all the flat particles are parallel or there is some cementation). The bedding or structure shall also be noted (e.g., stratified, lensed, nonstratified, heterogeneous varved).

#### **5.2.8 Summary of Soil Classification**

In summary, soils shall be classified in a similar manner by each geologist/engineer at a project site. The hierarchy of classification is as follows:

- Density and/or consistency
- Color
- Plasticity (Optional)
- Soil types
- Moisture content
- Stratification
- Texture, fabric, bedding
- Other distinguishing features

Subject  BOREHOLE AND SAMPLE LOGGING	Number GH-1.5	Page 10 of 20
	Revision 2	Effective Date 01/2012

### FIGURE 3

#### BEDDING THICKNESS CLASSIFICATION

Thickness (metric)	Thickness (Approximate English Equivalent)	Classification
> 1.0 meter	> 3.3'	Massive
30 cm - 1 meter	1.0' - 3.3'	Thick Bedded
10 cm - 30 cm	4" - 1.0'	Medium Bedded
3 cm - 10 cm	1" - 4"	Thin Bedded
1 cm - 3 cm	2/5" - 1"	Very Thin Bedded
3 mm - 1 cm	1/8" - 2/5"	Laminated
1 mm - 3 mm	1/32" - 1/8"	Thinly Laminated
< 1 mm	<1/32"	Micro Laminated

(Weir, 1973 and Ingram, 1954)



Subject  BOREHOLE AND SAMPLE LOGGING	Number GH-1.5	Page 11 of 20
	Revision 2	Effective Date 01/2012

### 5.3 Classification of Rocks

Rocks are grouped into three main divisions: sedimentary, igneous and metamorphic. Sedimentary rocks are by far the predominant type exposed at the earth's surface. The following basic names are applied to the types of rocks found in sedimentary sequences:

- Sandstone - Made up predominantly of granular materials ranging between 1/16 to 2 mm in diameter.
- Siltstone - Made up of granular materials less than 1/16 to 1/256 mm in diameter. Fractures irregularly. Medium thick to thick bedded.
- Claystone - Very fine-grained rock made up of clay and silt-size materials. Fractures irregularly. Very smooth to touch. Generally has irregularly spaced pitting on surface of drilled cores.
- Shale - A fissile very fine-grained rock. Fractures along bedding planes.
- Limestone - Rock made up predominantly of calcite ( $\text{CaCO}_3$ ). Effervesces strongly upon the application of dilute hydrochloric acid.
- Coal - Rock consisting mainly of organic remains.
- Others - Numerous other sedimentary rock types are present in lesser amounts in the stratigraphic record. The local abundance of any of these rock types is dependent upon the depositional history of the area. Conglomerate, halite, gypsum, dolomite, anhydrite, lignite, etc. are some of the rock types found in lesser amounts.

In classifying a sedimentary rock the following hierarchy shall be noted:

- Rock type
- Color
- Bedding thickness
- Hardness
- Fracturing
- Weathering
- Other characteristics

#### 5.3.1 **Rock Type**

As described above, there are numerous types of sedimentary rocks. In most cases, a rock will be a combination of several grain types, therefore, a modifier such as a sandy siltstone, or a silty sandstone can be used. The modifier indicates that a significant portion of the rock type is composed of the modifier. Other modifiers can include carbonaceous, calcareous, siliceous, etc.

Grain size is the basis for the classification of clastic sedimentary rocks. Figure 4 is the Udden-Wentworth classification that will be assigned to sedimentary rocks. The individual boundaries are slightly different than the USCS subdivision for soil classification. For field determination of grain sizes, a scale can be used for the coarse grained rocks. For example, the division between siltstone and claystone may not be measurable in the field. The boundary shall be determined by use of a hand lens. If the grains cannot be seen with the naked eye but are distinguishable with a hand lens, the rock is a siltstone. If the grains are not distinguishable with a hand lens, the rock is a claystone.

Subject  BOREHOLE AND SAMPLE LOGGING	Number GH-1.5	Page 12 of 20
	Revision 2	Effective Date 01/2012

## FIGURE 4

### GRAIN SIZE CLASSIFICATION FOR ROCKS

Particle Name	Grain Size Diameter
Cobbles	> 64 mm
Pebbles	4 - 64 mm
Granules	2 - 4 mm
Very Coarse Sand	1 - 2 mm
Coarse Sand	0.5 - 1 mm
Medium Sand	0.25 - 0.5 mm
Fine Sand	0.125 - 0.25 mm
Very Fine Sand	0.0625 - 0.125 mm
Silt	0.0039 - 0.0625 mm

After Wentworth, 1922

Subject  BOREHOLE AND SAMPLE LOGGING	Number GH-1.5	Page 13 of 20
	Revision 2	Effective Date 01/2012

### 5.3.2 Color

The color of a rock can be determined in a similar manner as for soil samples. Rock core samples shall be classified while wet, when possible, and air cored samples shall be scraped clean of cuttings prior to color classifications.

Rock color charts shall not be used unless specified by the Project Manager.

### 5.3.3 Bedding Thickness

The bedding thickness designations applied to soil classification (see Figure 3) will also be used for rock classification.

### 5.3.4 Hardness

The hardness of a rock is a function of the compaction, cementation, and mineralogical composition of the rock. A relative scale for sedimentary rock hardness is as follows:

- Soft - Weathered, considerable erosion of core, easily gouged by screwdriver, scratched by fingernail. Soft rock crushes or deforms under pressure of a pressed hammer. This term is always used for the hardness of the saprolite (decomposed rock which occupies the zone between the lowest soil horizon and firm bedrock).
- Medium soft - Slight erosion of core, slightly gouged by screwdriver, or breaks with crumbly edges from single hammer blow.
- Medium hard - No core erosion, easily scratched by screwdriver, or breaks with sharp edges from single hammer blow.
- Hard - Requires several hammer blows to break and has sharp conchoidal breaks. Cannot be scratched with screwdriver.

Note the difference in usage here of the words "scratch" and "gouge." A scratch shall be considered a slight depression in the rock (do not mistake the scraping off of rock flour from drilling with a scratch in the rock itself), while a gouge is much deeper.

### 5.3.5 Fracturing

The degree of fracturing or brokenness of a rock is described by measuring the fractures or joint spacing. After eliminating drilling breaks, the average spacing is calculated and the fracturing is described by the following terms:

- Very broken (V. BR.) - Less than 2-inch spacing between fractures
- Broken (BR.) - 2-inch to 1-foot spacing between fractures
- Blocky (BL.) - 1- to 3-foot spacing between fractures
- Massive (M.) - 3 to 10-foot spacing between fractures

The structural integrity of the rock can be approximated by calculating the Rock Quality Designation (RQD) of cores recovered. The RQD is determined by adding the total lengths of all pieces exceeding 4 inches and dividing by the total length of the coring run, to obtain a percentage.

Method of Calculating RQD

Subject  BOREHOLE AND SAMPLE LOGGING	Number GH-1.5	Page 14 of 20
	Revision 2	Effective Date 01/2012

(After Deere, 1964)

$$RQD \% = r/l \times 100$$

r = Total length of all pieces of the lithologic unit being measured, which are greater than 4 inches length, and have resulted from natural breaks. Natural breaks include slickensides, joints, compaction slicks, bedding plane partings (not caused by drilling), friable zones, etc.

l = Total length of the coring run.

### 5.3.6 Weathering

The degree of weathering is a significant parameter that is important in determining weathering profiles and is also useful in engineering designs. The following terms can be applied to distinguish the degree of weathering:

- Fresh - Rock shows little or no weathering effect. Fractures or joints have little or no staining and rock has a bright appearance.
- Slight - Rock has some staining which may penetrate several centimeters into the rock. Clay filling of joints may occur. Feldspar grains may show some alteration.
- Moderate - Most of the rock, with exception of quartz grains, is stained. Rock is weakened due to weathering and can be easily broken with hammer.
- Severe - All rock including quartz grains is stained. Some of the rock is weathered to the extent of becoming a soil. Rock is very weak.

### 5.3.7 Other Characteristics

The following items shall be included in the rock description:

- Description of contact between two rock units. These can be sharp or gradational.
- Stratification (parallel, cross stratified).
- Description of any filled cavities or vugs.
- Cementation (calcareous, siliceous, hematitic).
- Description of any joints or open fractures.
- Observation of the presence of fossils.
- Notation of joints with depth, approximate angle to horizontal, any mineral filling or coating, and degree of weathering.

All information shown on the boring logs shall be neat to the point where it can be reproduced on a copy machine for report presentation. The data shall be kept current to provide control of the drilling program and to indicate various areas requiring special consideration and sampling.

### 5.3.8 Additional Terms Used in the Description of Rock

The following terms are used to further identify rocks:

- Seam - Thin (12 inches or less), probably continuous layer.

Subject  BOREHOLE AND SAMPLE LOGGING	Number GH-1.5	Page 15 of 20
	Revision 2	Effective Date 01/2012

- Some - Indicates significant (15 to 40 percent) amounts of the accessory material. For example, rock composed of seams of sandstone (70 percent) and shale (30 percent) would be "sandstone -- some shale seams."
- Few - Indicates insignificant (0 to 15 percent) amounts of the accessory material. For example, rock composed of seam of sandstone (90 percent) and shale (10 percent) would be "sandstone -- few shale seams."
- Interbedded - Used to indicate thin or very thin alternating seams of material occurring in approximately equal amounts. For example, rock composed of thin alternating seams of sandstone (50 percent) and shale (50 percent) would be "interbedded sandstone and shale."
- Interlayered - Used to indicate thick alternating seams of material occurring in approximately equal amounts.

The preceding sections describe the classification of sedimentary rocks. The following are some basic names that are applied to igneous rocks:

- Basalt - A fine-grained extrusive rock composed primarily of calcic plagioclase and pyroxene.
- Rhyolite - A fine-grained volcanic rock containing abundant quartz and orthoclase. The fine-grained equivalent of a granite.
- Granite - A coarse-grained plutonic rock consisting essentially of alkali feldspar and quartz.
- Diorite - A coarse-grained plutonic rock consisting essentially of sodic plagioclase and hornblende.
- Gabbro - A coarse-grained plutonic rock consisting of calcic plagioclase and clinopyroxene. Loosely used for any coarse-grained dark igneous rock.

The following are some basic names that are applied to metamorphic rocks:

- Slate - A very fine-grained foliated rock possessing a well developed slaty cleavage. Contains predominantly chlorite, mica, quartz, and sericite.
- Phyllite - A fine-grained foliated rock that splits into thin flaky sheets with a silky sheen on cleavage surface.
- Schist - A medium to coarse-grained foliated rock with subparallel arrangement of the micaceous minerals which dominate its composition.
- Gneiss - A coarse-grained foliated rock with bands rich in granular and platy minerals.
- Quartzite - A fine- to coarse-grained nonfoliated rock breaking across grains, consisting essentially of quartz sand with silica cement.

#### 5.4 **Abbreviations**

Abbreviations may be used in the description of a rock or soil. However, they shall be kept at a minimum. Following are some of the abbreviations that may be used:

C	-	Coarse	Lt	-	Light	Yl	-	Yellow
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Subject  BOREHOLE AND SAMPLE LOGGING	Number GH-1.5	Page 16 of 20
	Revision 2	Effective Date 01/2012

Med - Medium	BR - Broken	Or - Orange
F - Fine	BL - Blocky	SS - Sandstone
V - Very	M - Massive	Sh - Shale
Sl - Slight	Br - Brown	LS - Limestone
Occ - Occasional	Bl - Black	Fgr - Fine-grained
Tr - Trace		

## 5.5 Boring Logs and Documentation

This section describes in more detail the procedures to be used in completing boring logs in the field. Information obtained from the preceding sections shall be used to complete the logs. A sample boring log has been provided as Figure 5.

The field geologist/engineer shall use this example as a guide in completing each boring log. Each boring log shall be fully described by the geologist/engineer as the boring is being drilled. Every sheet contains space for 25 feet of log. Information regarding classification details is provided either on the back of the boring log or on a separate sheet, for field use.

### 5.5.1 Soil Classification

- Identify site name, boring number, job number, etc. Elevations and water level data to be entered when surveyed data is available.
- Enter sample number (from SPT) under appropriate column. Enter depth sample was taken from (1 block = 1 foot). Fractional footages, i.e., change of lithology at 13.7 feet, shall be lined off at the proportional location between the 13- and 14-foot marks. Enter blow counts (Standard Penetration Resistance) diagonally (as shown). Standard penetration resistance is covered in Section 5.2.3.
- Determine sample recovery/sample length as shown. Measure the total length of sample recovered from the split-spoon sampler, including material in the drive shoe. Do not include cuttings or wash material that may be in the upper portion of the sample tube.
- Indicate any change in lithology by drawing a line at the appropriate depth. For example, if clayey silt was encountered from 0 to 5.5 feet and shale from 5.5 to 6.0 feet, a line shall be drawn at this increment. This information is helpful in the construction of cross-sections. As an alternative, symbols may be used to identify each change in lithology.
- The density of granular soils is obtained by adding the number of blows for the last two increments. Refer to Density of Granular Soils Chart on back of log sheet. For consistency of cohesive soils refer also to the back of log sheet - Consistency of Cohesive Soils. Enter this information under the appropriate column. Refer to Section 5.2.3.

Subject

BOREHOLE AND SAMPLE LOGGING

Number

GH-1.5

Page

17 of 20

Revision

2

Effective Date

01/2012

**FIGURE 5**  
**COMPLETED BORING LOG (EXAMPLE)**

**BORING LOG**Page 1 of 1

PROJECT NAME:  
PROJECT NUMBER:  
DRILLING COMPANY:  
DRILLING RIG:

NSB - SITE  
9594  
SOILTEST CO.  
CME-55

BORING NUMBER: SB/MW 1  
DATE: 3/8/96  
GEOLOGIST: SJ CONTI  
DRILLER: R. ROCK

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION			U S C S *	Remarks	PID/FID Reading (ppm)			
					Soil Density/Consistency or Rock Hardness	Color	Material Classification			Sample	Sampler BZ	Borehole**	Driller BZ**
S-1 e 0800	0.0 2.0	7 9	1.5/2.0 10		M DENSE	BRN TO BLK	SILTY SAND - SOME Rock FR. - TR BRICKS (FILL)	SM	MOIST SL. ORG. ODOR FILL TO 4'±	5	0	0	0
	4.0			4.0									
S-2 e 0810		5 7	2.9/2.0 8		M DENSE	BRN	SILTY SAND - TR FINE GRAVEL	SM	MOIST - W ODOR NAT. MATL. TOOK SAMPLE SB01-0406 FOR ANALYSIS	10	0	-	-
	6.0			7.0 ±									
	8.0			8.0									
S-3 e 0820		6 8	1.9/2.0 16		DENSE	TAN GRN	FINE TO COARSE SAND TR.F. GRAVEL	SW	WET HIT WATER: 7'±	0	0	0	0
	10.0												
	12.0			12.0									
S-4 e 0830		7 6	1.6/2.0 8		STIFF	GRAY	SILTY CLAY	CL	MOIST → WET	0	.5	-	-
	14.0			15.0					AUGER REF @ 15'				
	15.0			16	M HARD	BRN	SILTSTONE	VER	WEATHERED				
				19'					LO 4 JNTS @ 15.5 WATER STAINS @ 16.5, 17.1, 17.5	0	0	0	0
9/5 ①			4.0/5.0						LOSING SOME				
	20.0				HARD	GRAY	SANDSTONE - SOME SILTSTONE	BR	DRILL H2O @ 17'± SET TEMP 6" CAS TO 15.5				
									SET 2"Ø PVC SCREEN 16-25	0	0	0	0
4.9 5.0 ②			5.0/5.0						SAND 14-25				
	25.0			25					PELLETS 12-14				

\* When rock coring, enter rock brokenness.

\*\* Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated response read.

Remarks: CME-55 RIG, 4 1/4" ID HSA - 9" OD ±2" SPLIT SPOONS - 140 LB HAMMER - 30" DROPNX CORE IN BEDROCK RUN (1) = 25 min, RUN (2) = 15 min

Converted to Well:

Yes

No

Well I.D. #:

MW-1

• 1-20Z  
1-80Z

Drilling Area

Background (ppm):

0

Subject  BOREHOLE AND SAMPLE LOGGING	Number GH-1.5	Page 18 of 20
	Revision 2	Effective Date 01/2012

- Enter color of the material in the appropriate column.
- Describe material using the USCS. Limit this column for sample description only. The predominant material is described last. If the primary soil is silt but has fines (clay) - use clayey silt. Limit soil descriptors to the following:
  - Trace: 0 - 10 percent
  - Some: 11 - 30 percent
  - And/Or: 31 - 50 percent
- Also indicate under Material Classification if the material is fill or natural soils. Indicate roots, organic material, etc.
- Enter USCS symbol - use chart on back of boring log as a guide. If the soils fall into one of two basic groups, a borderline symbol may be used with the two symbols separated by a slash. For example ML/CL or SM/SP.
- The following information shall be entered under the "Remarks" column and shall include, but is not limited by, the following:
  - Moisture - estimate moisture content using the following terms - dry, moist, wet and saturated. These terms are determined by the individual. Whatever method is used to determine moisture, be consistent throughout the log.
  - Angularity - describe angularity of coarse grained particles using the terms angular, subangular, subrounded, or rounded. Refer to ASTM D 2488 or Earth Manual for criteria for these terms.
  - Particle shape - flat, elongated, or flat and elongated.
  - Maximum particle size or dimension.
  - Water level observations.
  - Reaction with HCl - none, weak, or strong.
- Additional comments:
  - Indicate presence of mica, caving of hole, when water was encountered, difficulty in drilling, loss or gain of water.
  - Indicate odor and Photoionization Detector (PID) or Flame Ionization Detector (FID) reading if applicable.
  - Indicate any change in lithology by drawing a line through the lithology change column and indicate the depth. This will help when cross-sections are subsequently constructed.
  - At the bottom of the page indicate type of rig, drilling method, hammer size and drop, and any other useful information (i.e., borehole size, casing set, changes in drilling method).
  - Vertical lines shall be drawn (as shown in Figure 5) in columns 6 to 8 from the bottom of each sample to the top of the next sample to indicate consistency of material from sample to sample, if the material is consistent. Horizontal lines shall be drawn if there is a change in lithology, then vertical lines drawn to that point.



Subject  BOREHOLE AND SAMPLE LOGGING	Number GH-1.5	Page 19 of 20
	Revision 2	Effective Date 01/2012

- Indicate screened interval of well, as needed, in the lithology column. Show top and bottom of screen. Other details of well construction are provided on the well construction forms.

### 5.5.2 Rock Classification

- Indicate depth at which coring began by drawing a line at the appropriate depth. Indicate core run depths by drawing coring run lines (as shown) under the first and fourth columns on the log sheet. Indicate RQD, core run number, RQD percent, and core recovery under the appropriate columns.
- Indicate lithology change by drawing a line at the appropriate depth as explained in Section 5.5.1.
- Rock hardness is entered under designated column using terms as described on the back of the log or as explained earlier in this section.
- Enter color as determined while the core sample is wet; if the sample is cored by air, the core shall be scraped clean prior to describing color.
- Enter rock type based on sedimentary, igneous or metamorphic. For sedimentary rocks use terms as described in Section 5.3. Again, be consistent in classification. Use modifiers and additional terms as needed. For igneous and metamorphic rock types use terms as described in Sections 5.3.8.
- Enter brokenness of rock or degree of fracturing under the appropriate column using symbols VBR, BR, BL, or M as explained in Section 5.3.5 and as noted on the back of the Boring Log.
- The following information shall be entered under the remarks column. Items shall include but are not limited to the following:
  - Indicate depths of joints, fractures and breaks and also approximate to horizontal angle (such as high, low), i.e., 70E angle from horizontal, high angle.
  - Indicate calcareous zones, description of any cavities or vugs.
  - Indicate any loss or gain of drill water.
  - Indicate drop of drill tools or change in color of drill water.
- Remarks at the bottom of Boring Log shall include:
  - Type and size of core obtained.
  - Depth casing was set.
  - Type of rig used.
- As a final check the boring log shall include the following:
  - Vertical lines shall be drawn as explained for soil classification to indicate consistency of bedrock material.
  - If applicable, indicate screened interval in the lithology column. Show top and bottom of screen. Other details of well construction are provided on the well construction forms.

### 5.5.3 Classification of Soil and Rock from Drill Cuttings

The previous sections describe procedures for classifying soil and rock samples when cores are obtained. However, some drilling methods (air/mud rotary) may require classification and borehole

Subject  BOREHOLE AND SAMPLE LOGGING	Number GH-1.5	Page 20 of 20
	Revision 2	Effective Date 01/2012

logging based on identifying drill cuttings removed from the borehole. Such cuttings provide only general information on subsurface lithology. Some procedures that shall be followed when logging cuttings are:

- Obtain cutting samples at approximately 5-foot intervals, sieve the cuttings (if mud rotary drilling) to obtain a cleaner sample, place the sample into a small sample bottle or "zip lock" bag for future reference, and label the jar or bag (i.e. hole number, depth, date, etc.). Cuttings shall be closely examined to determine general lithology.
- Note any change in color of drilling fluid or cuttings, to estimate changes in lithology.
- Note drop or chattering of drilling tools or a change in the rate of drilling, to determine fracture locations or lithologic changes.
- Observe loss or gain of drilling fluids or air (if air rotary methods are used), to identify potential fracture zones.
- Record this and any other useful information onto the boring log as provided in Figure 1.

This logging provides a general description of subsurface lithology and adequate information can be obtained through careful observation of the drilling process. It is recommended that split-barrel and rock core sampling methods be used at selected boring locations during the field investigation to provide detailed information to supplement the less detailed data generated through borings drilled using air/mud rotary methods.

## **5.6        Review**

Upon completion of the borings logs, copies shall be made and reviewed. Items to be reviewed include:

- Checking for consistency of all logs.
- Checking for conformance to the guideline.
- Checking to see that all information is entered in their respective columns and spaces.

## **6.0        REFERENCES**

Unified Soil Classification System (USCS).

ASTM D2488, 1985.

Earth Manual, U.S. Department of the Interior, 1974.

## **7.0        RECORDS**

Originals of the boring logs shall be retained in the project files.

## **STANDARD OPERATING PROCEDURE**

### **SOP-08**

## **SURFACE AND SUBSURFACE SOIL SAMPLING**

### **1.0 PURPOSE**

This Standard Operating Procedure (SOP) describes the procedures to be used for surface and subsurface soil sampling using direct-push technology (DPT) or hand augers during field activities.

### **2.0 REQUIRED FIELD FORMS AND EQUIPMENT**

**Writing utensil (preferably black pen with indelible ink)**

**Disposable medical-grade gloves (i.e. latex, nitrile)**

**Boring log (for DPT sampling) or Soil sample logsheets (for hand augering)**

**Stainless-steel mixing bowls**

**Stainless-steel trowel, soup spoon, and/or Disposable trowels**

**Required sample containers:** All sample containers including shipping coolers for analysis by fixed-base laboratories will be supplied and certified clean by the laboratory.

**Required decontamination materials (SOP-14)**

**Chain-of-custody records**

**Required personnel protective equipment (PPE)**

**Wooden stakes or pin flags**

**Marking Paint**

**Sealable polyethylene bags**

**Heavy-duty cooler**

**Ice**

**DPT Probe Rig and sampling equipment (SOP-06)**

**Sample labels (SOP-02)**

### **3.0 COLLECTION OF OTHER SOIL SAMPLE ALIQUOTS**

When soil cores are collected using DPT, such as Geoprobe®, 2-foot soil intervals will be collected in clear acetate tubes, which can be extracted from the Geoprobe® core barrel upon retrieval at the surface (see SOP-06). Note: A surface soil sample is collected from the 0- to 2-foot depth. Additional subsurface soil samples each consist of 2-foot core segments.

The driller or helper will slit the acetate liner lengthwise with a razor knife, remove a section of the liner, and expose the length of the soil interval (see SOP-06).

3.1 The non-VOC soil interval will be composited and used to fill the sample containers. Any surface debris (e.g., vegetation, twigs, rocks, litter, etc.) should first be removed from the top of the surface soil core. For other core intervals, the top 2 inches of each core should be discarded because it often contains material scraped from the side of the borehole and not fresh material from the bottom of the borehole.

3.2 Slide the remaining core material out of the acetate liner and into a clean, decontaminated stainless-steel mixing bowl. Mix the soil thoroughly with a stainless-steel spoon and remove gravel, large pebbles, roots, twigs, and other coarse materials. Fill the required sample containers in the following order:

- Containers for organic analyses
- Container for metals
- Container for pH

3.3 Complete all required information on the sample labels (see SOP-02).

3.4 Place the sample container in a ziplock plastic bag (or similar) and seal shut. Place the bag in a cooler containing ice and cool to  $\leq 6^{\circ}\text{C}$ .

3.5 Record the required information on the Boring Log and the COC Record form.

#### **4.0 COLLECTION OF SOIL SAMPLES USING A HAND AUGER**

4.1 Utilizing a properly decontaminated stainless steel trowel or disposable trowel, remove the sample material from the bucket bit and place into a properly decontaminated stainless steel mixing bowl. After collection of VOC (or other grab) samples, mix the soil thoroughly and remove gravel, large pebbles, roots, twigs, and other coarse materials.

4.2 Fill the required sample containers for analysis.

4.3 Complete all required information on the sample labels (see SOP-02).

- 4.4 Place the sample container in a Ziploc plastic bag (or similar) and seal shut. Place the bag in a cooler containing ice and cool to  $4^{\circ}\text{C} \pm 2^{\circ}\text{C}$ .
- 4.5 Record the required information on the Soil Sample Log Sheet and the COC Record form.

## **5.0 PACKAGING AND SHIPPING OF SAMPLES**

Samples will be packaged and shipped according to SOP-05.

## **6.0 ATTACHMENTS**

1. Soil and Sediment Sample Log Sheet
2. Boring Log

## SOIL AND SEDIMENT SAMPLE LOG SHEET

Circle if Applicable:		Signature(s):
MS/MSD	Duplicate ID No.:	



## **STANDARD OPERATING PROCEDURE**

### **SOP-09**

#### **MONITORING WELL DEVELOPMENT (WITHOUT DRILLER)**

##### **1.0 PURPOSE**

This procedure provides general guidance and information pertaining to proper development of new and existing monitoring wells.

##### **2.0 EQUIPMENT, TOOLS, AND SUPPLIES**

The following list includes equipment and items required for monitoring well installation:

**Health and safety equipment** as required by the HASP and the site safety officer.

**Well development equipment with associated materials:**

- pump (typical pumps include whale pumps, watterra, or other submersible pumps) or bailer
- battery (if needed to run pump)
- tubing as needed (e.g. watterra, peristaltic, whale pump)
- water quality meter, and turbidity meter (if not included in water quality meter)
- PID for health and safety
- surge block (if needed)
- bucket with lid or 55-gallon drum for purge water (purge water may be further staged in a large poly tank at a staging area)
- well development log, ink pen, clip board
- well data including completed well installation form with screened interval data
- water level indicator
- calculator



### 3.0 WELL DEVELOPMENT METHODS

The development of new wells will not occur until at least 48 hours after the well has been installed and grouted. This time is required so that the grout in the annulus can set and harden. The purpose of well development is to stabilize and increase the permeability of the sand pack and the well screen and to restore the permeability of the formation that may have been reduced by drilling operations. Wells are typically developed until all fine material and drilling water, if any, is removed from the well.

Sequential periodic measurements of pH, specific conductance, turbidity, and temperature taken during development yield information (stabilized values) that sufficient development is reached. Development should proceed until criteria are met as stated in Navy Guidelines.

A surge plunger (also called a surge block) that is approximately the same diameter as the well casing will be used to agitate the water. There are two basic types of surge plungers, solid and valved surge plungers. Site-specific conditions will dictate which type will be used. In formations with low yields, a valved surge plunger may be preferred because solid plungers tend to force water out of the well at a greater rate than it will flow back in. Valved plungers are designed to produce a greater inflow than outflow of water during surging.

Surging causes water to move in and out of the well screens. This movement of water pulls fine materials into the well, preventing bridging of sand particles in the gravel pack. These fine materials can then be removed by any of several methods such as submersible pumps (i.e. whale pumps), bailers, or even peristaltic pumps. Whale pumps can be used to surge and sweep the well screen as it pumps. Another alternative method for development would be to utilize a waterra (i.e. check valve method). This method allows for surging and purging of the well by moving the tubing in an up and down motion. On the downward stroke, the ball in the foot valve lifts and the tubing fills with water; and on the upward stroke the ball is set and surged ground water is forced out of the tubing and into a purge bucket.

Development should proceed until the following criteria are met:

- The well water is clear to the unaided eye.

and

- A minimum removal of five times the standing water volume in the well (to include the well screen and casing plus saturated borehole annulus, assuming 30% annular porosity).

or

- When pH measurements remain constant within 0.1 Standard Units and specific conductance and temperature vary no more than plus or minus 3 percent for at least three consecutive readings. Turbidity should also show stabilization and ideally be below 10 nephelometric turbidity units (NTUs).

or

- If the well has been purged dry at least three times while waiting 15 to 20 minutes to allow the well to recharge between pumping intervals. Recharge rates will be documented while the well is allowed to recover.

If for any reason the above criteria cannot be met, the site geologist should document the event in writing and consult with the Project Manager regarding an alternate plan of action.

Well development must be completed at least 24 hours before well sampling. The intent of this hiatus is to provide time for the newly installed well and backfill materials to sufficiently equilibrate to their new environment and for the new environment to re-stabilize after the disturbance of drilling. All development water should be handled in accordance with IDW standards.

#### **4.0 ATTACHMENTS**

1. Monitoring Well Development Record



## Page \_\_\_\_ of \_\_\_\_

Well: \_\_\_\_\_ Depth to Bottom (ft.): \_\_\_\_\_ Responsible Personnel: \_\_\_\_\_  
 Site: \_\_\_\_\_ Static Water Level Before (ft.): \_\_\_\_\_ Drilling Company: \_\_\_\_\_  
 Date Installed: \_\_\_\_\_ Static Water Level After (ft.): \_\_\_\_\_ Project Name: \_\_\_\_\_  
 Date Developed: \_\_\_\_\_ Screen Length (ft.): \_\_\_\_\_ Project Number: \_\_\_\_\_  
 Dev. Method: \_\_\_\_\_ One Well Volume (gal/L): \_\_\_\_\_ PID Readings: Bore Hole \_\_\_\_\_ ppm  
 Pump Type: \_\_\_\_\_ Casing ID (in.): \_\_\_\_\_ PID Readings: Breathing Zone \_\_\_\_\_ ppm

[illegible]

**ATTACHMENT 1**  
**MONITORING WELL DEVELOPMENT RECORD**

## **STANDARD OPERATING PROCEDURE**

### **SOP-10**

## **MEASUREMENT OF WATER LEVELS IN MONITORING WELLS**

### **1.0 PURPOSE**

This Standard Operating Procedure (SOP) establishes procedures for determining water levels in monitoring wells.

### **2.0 EQUIPMENT, TOOLS, AND FIELD FORMS**

**Ground Water Level Measurement Form:** A copy of the Ground Water Level Measurement Form is attached.

**Bound field logbook**

**PPE – Nitrile Gloves, safety glasses**

**Well key**

**Writing utensil, clipboard**

**Electronic water-level indicator or interface probe:** The water-level indicator/interface probe must have a cable of sufficient length to reach the water surface and be capable of measurements of 0.01 foot.

**Decontamination supplies:** SOP-14 describes decontamination procedures including decontamination supplies.

### **3.0 WATER-LEVEL MEASUREMENT PROCEDURES**

3.1 Check the operation of the electronic water-level indicator or interface meter. Ensure that the water-level indicator probe has been decontaminated before use, in accordance with standard procedures.

3.2 Record the well identification (ID), date, and time (using military time) on the Ground Water-Level Measurement Form. Don PPE (nitrile gloves, safety glasses) as required.

3.3 Unlock the well and remove the well cap. If a bladder pump is installed, remove the outflow tubing.

- 3.4 Place the well cap (and tubing if a bladder pump is installed) on a clean surface.
- 3.5 Find the surveyed reference point on the well casing where the reading will be recorded from.
- 3.6 Slowly lower the probe into the well riser pipe until an audible and/or visible signal is produced, indicating contact with the water surface.
- 3.7 Read the ground water-level measurement from the top of the inner casing at the surveyed reference point to the nearest 0.01 foot.
- 3.8 Record the water-level measurement on the Ground Water Level Measurement Form.
- 3.9 If a bottom measurement is needed (especially important for newly installed monitoring wells), turn the meter off and measure the bottom of the well from the surveyed reference point.
- 3.10 Wind the meter cable measuring tape back onto the spool.
- 3.11 Replace the well cap and lock.
- 3.12 Decontaminate the meter's probe and cable following the procedures outlined in SOP-14.
- 3.13 Containerize any decontamination fluids and PPE in accordance with the procedures described in SOP-15.

#### **4.0 ATTACHMENTS**

1. Ground Water Level Measurement Sheet

# GROUND WATER LEVEL MEASUREMENT SHEET



Tetra Tech NUS, Inc.

# GROUNDWATER LEVEL MEASUREMENT SHEET

Project Name: \_\_\_\_\_ Project No.: \_\_\_\_\_  
 Location: \_\_\_\_\_ Personnel: \_\_\_\_\_  
 Weather Conditions: \_\_\_\_\_ Measuring Device: \_\_\_\_\_  
 Tidally Influenced: Yes \_\_\_\_\_ No \_\_\_\_\_ Remarks: \_\_\_\_\_

[illegible]

<sup>a</sup> All measurements to the nearest 0.01 foot.



# STANDARD OPERATING PROCEDURES

Number	SOP-11 SA-1.1	Page	1 of 34
Effective Date	01/2012	Revision	8
Applicability	Tetra Tech, Inc.		
Prepared	Earth Sciences Department		
Approved	J. Zimmerly		

Subject  
GROUNDWATER SAMPLE ACQUISITION AND  
ONSITE WATER QUALITY TESTING

## TABLE OF CONTENTS

<b><u>SECTION</u></b>	<b><u>PAGE</u></b>
<b>1.0 PURPOSE.....</b>	<b>2</b>
<b>2.0 SCOPE .....</b>	<b>2</b>
<b>3.0 GLOSSARY .....</b>	<b>2</b>
<b>4.0 RESPONSIBILITIES AND PERSONNEL QUALIFICATIONS.....</b>	<b>3</b>
<b>5.0 HEALTH AND SAFETY.....</b>	<b>4</b>
<b>6.0 PROCEDURES.....</b>	<b>5</b>
6.1 General .....	5
6.2 Sampling, Monitoring, and Evacuation Equipment.....	7
6.3 Calculations of Well Volume .....	8
6.4 Evacuation of Static Water – Purging .....	9
6.4.1 General .....	9
6.4.2 Evacuation Devices .....	9
6.5 Onsite Water Quality Testing.....	12
6.5.1 Measurement of pH .....	13
6.5.2 Measurement of Specific Conductance .....	15
6.5.3 Measurement of Temperature .....	16
6.5.4 Measurement of Dissolved Oxygen.....	17
6.5.5 Measurement of Oxidation-Reduction Potential .....	19
6.5.6 Measurement of Salinity .....	20
6.5.7 Measurement of Turbidity .....	21
6.6 Sampling .....	22
6.6.1 Sampling Plan.....	22
6.6.2 Sampling Methods as Related to Low-Flow Sampling .....	23
6.7 Low-Flow Purging and Sampling.....	25
6.7.1 Scope and Application .....	25
6.7.2 Equipment.....	25
6.7.3 Purging and Sampling Procedure.....	26
<b>7.0 REFERENCES.....</b>	<b>28</b>
<b><u>ATTACHMENTS</u></b>	
A PURGING EQUIPMENT SELECTION .....	29
B GROUNDWATER SAMPLE LOG SHEET .....	32
C EQUIPMENT CALIBRATION LOG.....	33
D LOW FLOW PURGE DATA SHEET .....	34

Subject GROUNDWATER SAMPLE ACQUISITION AND ONSITE WATER QUALITY TESTING	Number SA-1.1	Page 2 of 34
	Revision 8	Effective Date 01/2012

## 1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the process to be used for purging groundwater monitoring wells prior to sampling, for collecting groundwater samples, and for measuring groundwater quality parameters.

## 2.0 SCOPE

This document provides information on proper sampling equipment, onsite water quality testing, safety measures to ensure the safety of the field technician(s), and techniques for groundwater sampling. All personnel are encouraged to review the information contained herein to facilitate planning of the field sampling effort. The techniques described shall be followed whenever applicable, noting that site-specific conditions or project-specific plans may require modifications to methodology.

## 3.0 GLOSSARY

Conductivity – Conductivity is a numerical expression of the ability of an aqueous solution to carry an electric current. This ability depends on the presence of ions and their total concentration, mobility, valence, and relative concentrations and on temperature. Conductivity is highly dependent on temperature and should be reported at a particular temperature, i.e., 20.2 microSiemens per centimeter (mS/cm) at 14°C.

Dissolved Oxygen (DO) – DO levels in natural and wastewater depend on the physical, chemical, and biochemical activities in the water sample.

Groundwater Sample – A quantity of water removed from the ground, usually via a monitoring well that may or may not be lined with a well casing.

Oxidation-Reduction Potential (ORP) - A measure of the activity ratio of oxidizing and reducing species as determined by the electromotive force developed by a noble metal electrode immersed in water, as referenced against a reference electrode. A reference electrode commonly used in the field is the silver/silver chloride electrode, which has a voltage offset of about 210 mV from the standard hydrogen electrode (SHE). To convert field ORP measurements to equivalent SHE values, approximately 210 mV must be added to the ORP values obtained using the silver/silver chloride electrode. The actual offset depends on the concentration of the potassium chloride (KCl) in the field reference electrode and the temperature. Offsets typically range from 199 (saturated KCl) to 205 (3.5 Molar KCl) to 222 mV (1 Molar KCl) at 25°C and are greater at lower temperatures.

pH - The negative logarithm (base 10) of the hydrogen ion activity. The hydrogen ion activity is related to the hydrogen ion concentration, and, in a relatively weak solution, the two are nearly equal. Thus, for all practical purposes, pH is a measure of the hydrogen ion concentration.

pH Paper - Indicator paper that turns different colors depending on the pH of the solution to which it is exposed. Comparison with color standards supplied by the manufacturer will then give an indication of the solution's pH.

Representativeness – A qualitative description of the degree to which an individual sample accurately reflects population characteristics or parameter variations at a sampling point. It is therefore an important characteristic not only of assessment and quantification of environmental threats posed by the site, but also for providing information for engineering design and construction. Proper sample location selection and proper sample collection methods are important to ensure that a truly representative sample has been collected.



Subject GROUNDWATER SAMPLE ACQUISITION AND ONSITE WATER QUALITY TESTING	Number SA-1.1	Page 3 of 34
	Revision 8	Effective Date 01/2012

Salinity – The measurement of dissolved salts in a given mass of solution. Note: most field meters determined salinity automatically from conductivity and temperature. The value will be displayed in either parts per thousand (ppt) or percent (e.g., 35 ppt equals 3.5 percent). The parts per thousand symbol ( $^0/_{00}$ ) is not the same as the percent symbol (%).

Turbidity – Turbidity in water is caused by suspended matter such as clay, silt, and fine organic and inorganic matter. Turbidity is an expression of the optical property that causes light to be scattered and absorbed rather than transmitted in a straight line through the sample.

#### 4.0 RESPONSIBILITIES AND PERSONNEL QUALIFICATIONS

Project Manager - The Project Manager is responsible for determining the sampling objectives, initial sampling locations, and field procedures used in the collection of groundwater samples. Additionally, in consultation with other project personnel (geologist, hydrogeologist, etc.), the Project Manager identifies sampling locations.

Site Safety Officer (SSO) - The SSO (or a qualified designee) is responsible for providing the technical support necessary to implement the project Health and Safety Plan (HASP). This includes but is not be limited to performing air quality monitoring during sampling, boring and excavation activities, and ensuring that workers and offsite (downwind) individuals are not exposed to hazardous levels of airborne contaminants. The SSO or SSO designee may also be required to advise the FOL on other safety-related matters regarding sampling, such as mitigative measures to address potential hazards from hazardous objects or conditions.

Project Geologist/Sampler - The project geologist/sampler is responsible for the proper acquisition of samples in accordance with this SOP or other project-specific documents. In addition, this individual is responsible for the completion of all required paperwork (e.g., sample log sheets, field notebook, boring logs, container labels, custody seals, and chain-of-custody forms) associated with the collection of those samples.

Project Hydrogeologist – This individual is responsible for selecting and detailing the specific groundwater sampling techniques, onsite water quality testing (type, frequency, and location), equipment to be used, and providing detailed input in this regard to the project planning documents. The project hydrogeologist is also responsible for properly briefing and overseeing the performance of site sampling personnel.

Field Operations Leader (FOL) – This individual is primarily responsible for the execution of the planning document containing the Sampling and Analysis Plan (SAP). This is accomplished through management of a field sampling team for the proper acquisition of samples. He or she is responsible for the supervision of onsite analyses; ensuring proper instrument calibration, care, and maintenance; sample collection and handling; the completion and accuracy of all field documentation; and making sure that custody of all samples obtained is maintained according to proper procedures. When appropriate and as directed by the FOL, such responsibilities may be performed by other qualified personnel (e.g., field technicians) where credentials and time permit. The FOL is ultimately responsible for adherence to Occupational Safety and Health Administration (OSHA) regulations during these operations through self acquisition or through the management of a field team of samplers.

General personnel qualifications for groundwater sample collection and onsite water quality testing include the following:

- Occupational Safety and Health Administration (OSHA) 40-hour and applicable refresher training.
- Capability of performing field work under the expected physical and environmental (i.e., weather) conditions.

Subject GROUNDWATER SAMPLE ACQUISITION AND ONSITE WATER QUALITY TESTING	Number SA-1.1	Page 4 of 34
	Revision 8	Effective Date 01/2012

- Familiarity with appropriate procedures for sample documentation, handling, packaging, and shipping.

## 5.0 HEALTH AND SAFETY

Specific safety and health precautions are identified throughout this SOP. In addition to those precautions, the following general hazards may be incurred during sampling activities:

- Knee injuries from kneeling on hard surfaces
- Slips, trips, and falls
- Cuts and lacerations
- Traffic hazards associated with sampling in parking areas and roadways and along highways.

Methods of avoiding these hazards are provided below.

**Knee injuries** – Many monitoring wells are installed as flush mounts. Personnel are required to kneel to open these wells and to take groundwater level measurements, etc. This could result in knee injuries from kneeling on stones/foreign objects and general damage due to stress on the joints. To combat this hazard:

- Clear any foreign objects from the work area.
- Wear hard-sided knee pads.

**Slips, Trips, and Falls** – These hazards exist while traversing varying terrains carrying equipment to sample wells. To minimize these hazards:

- Pre-survey well locations. Eliminate, barricade, or otherwise mark physical hazards leading to the locations.
- Carry small loads that do not restrict the field of vision.
- Travel the safest and clearest route (not necessarily the shortest).

**Cuts and Lacerations** – To prevent cuts and lacerations associated with groundwater sampling, the following provisions are required:

- Always cut away from yourself and others when cutting tubing or rope. This will prevent injury to yourself and others if the knife slips.
- Do not place items to be cut in your hand or on your knee.
- Change blades as necessary to maintain a sharp cutting edge. Many accidents result from struggling with dull cutting attachments.
- Whenever practical, wear cut-resistant gloves (e.g., leather or heavy cotton work gloves) at least on the hand not using the knife.
- Keep cutting surfaces clean and smooth.

Subject GROUNDWATER SAMPLE ACQUISITION AND ONSITE WATER QUALITY TESTING	Number SA-1.1	Page 5 of 34
	Revision 8	Effective Date 01/2012

- Secure items to be cut -- do not hold them against the opposing hand, a leg, or other body part.
- When transporting glassware, keep it in a hard-sided container such as a cooler so that if there is a fall, you will be less likely to get cut by broken glass.
- DO NOT throw broken glass or glass ampoules into garbage bags. Place broken glass and glass ampoules in hard-sided containers such as a cardboard box or directly into a dumpster. DO NOT reach into garbage bags to retrieve any item accidentally thrown away. Empty the contents onto a flat surface to avoid punctures and lacerations from reaching where you cannot see.

**Vehicular and Foot Traffic Hazards** – When sampling along the roadway or near traffic patterns, follow the following precautions:

- Motorists may be distracted by onsite activities – ASSUME THEY DO NOT SEE YOU OR MEMBERS OF YOUR FIELD CREW.
- DO NOT place obstructions (such as vehicles) along the sides of the road that may cause site personnel to move into the flow of traffic to avoid your activities or equipment or that will create a blind spot.
- **Provide a required free space of travel.** Maintain at least 6 feet of space between you and moving traffic. Where this is not possible, use flaggers and/or signs to warn oncoming traffic of activities near or within the travel lanes.
- Face Traffic. Whenever feasible, if you must move within the 6 feet of the required free space or into traffic, attempt to face moving traffic at all times. Always leave yourself an escape route.
- Wear high-visibility vests to increase visual recognition by motorists.
- Do not rely on the vehicle operator's visibility, judgment, or ability. Make eye contact with the driver. Carefully and deliberately use hand signals so they will not startle or confuse motorists or be mistaken for a flagger's direction before moving into traffic.
- Your movements may startle a motorist and cause an accident, so move deliberately. Do not make sudden movements that might confuse a motorist.

## 6.0 PROCEDURES

### 6.1 General

For information derived from a groundwater sample to be useful and accurate, the sample must be representative of the particular zone being sampled. The physical, chemical, and bacteriological integrity of the sample must be maintained from the time of sampling to the time of analysis to keep any changes in water quality parameters to a minimum.

#### **CAUTION**

A closed well may generate and accumulate gases due to biological degradation, evolution of volatile chemicals from groundwater into the air, or other chemical actions. These gases may also be artificially generated, such as in the case of air sparging or

Subject GROUNDWATER SAMPLE ACQUISITION AND ONSITE WATER QUALITY TESTING	Number SA-1.1	Page 6 of 34
	Revision 8	Effective Date 01/2012

extraction wells, which may take several days to depressurize. See Section 6.6.2 for safety measures to be employed to protect sampling personnel.

Methods for withdrawing samples from completed wells include the use of pumps, compressed air or nitrogen, bailers, and various types of samplers. The primary considerations in obtaining a representative sample of groundwater are to avoid collection of stagnant (standing) water in the well and to avoid physical or chemical alteration of the water sample due to external influences of the sampling technique(s). In a non-pumping well, there will be little or no vertical mixing of water in the well pipe or casing, and stratification will occur. The well water in the screened section will mix with groundwater due to normal flow patterns, but the well water above the screened section will remain isolated and become stagnant. Concentration gradients resulting from mixing and dispersion processes, layers of variable geologic permeability, and the presence of separate-phase product (e.g., floating hydrocarbons) may cause stratification. Excessive pumping or improper sampling methods can dilute or increase contaminant concentrations in the collected sample compared to what is representative of the integrated water column as it naturally occurs at that point, resulting in the collection of a non-representative sample. To safeguard against collecting non-representative samples, the following approach shall be followed prior to sample acquisition:

**CAUTION**

Mechanical agitation of well water may cause off-gas generation of volatile contaminants, creating an inhalation exposure to the sampler(s). Where avoiding an inhalation exposure is not possible and mechanical agitation is possible, pump into closed-top containers to control potential air emissions.

1. If possible, position yourself (and the sampling equipment) upwind of the well head.
2. Purge the monitoring well to be sampled prior to obtaining any samples from it. Evacuation of three to five well volumes is recommended prior to sampling, unless low-flow purging and sampling methods are utilized as described in Section 6.7 (Consult the site-specific SAP for exact purging parameters). In a high-yielding groundwater formation and where there is no stagnant water in the well above the screened section, extensive evacuation prior to sample withdrawal is not as critical as it is in a low-yielding well or in wells containing stagnant water.
3. For wells with low yields that are purged dry during sampling, evacuate the well and allow it to recover to 75 percent of full capacity prior to sample acquisition. If the recovery rate is fairly rapid (generally 300 mL per minute or greater), attempt to continue evacuation until the number of well volumes specified in the SAP is achieved. If this cannot be accomplished, allow recovery to 75 percent of capacity and begin sampling.

**CAUTION**

For moderate to high-yielding monitoring wells, an evacuation rate that does not cause excessive turbulence in the well should be selected. There is no absolute safeguard against contaminating the sample with stagnant water; hence, special techniques are required for purging to minimize the potential for sample contamination (see below).

4. For moderate to high-yielding monitoring wells, use one of the following purge techniques:
  - Place a submersible pump or the intake line of a surface pump or bailer just below the water surface when removing the stagnant water.

Subject GROUNDWATER SAMPLE ACQUISITION AND ONSITE WATER QUALITY TESTING	Number SA-1.1	Page 7 of 34
	Revision 8	Effective Date 01/2012

- While purging and as the water level decreases, lower the pump or intake line as the water level drops in the well. Three to five volumes of water shall be removed to provide reasonable assurance that all stagnant water has been evacuated. After this is accomplished, a bailer or other approved device may be used to collect the sample for analysis.
- Unless otherwise directed, place the intake line of the sampling pump (or the submersible pump itself) near the center of the screened section, and pump approximately one casing volume of water from the well at a low purge rate equal to the well's recovery rate (low-flow sampling).

## 6.2 **Sampling, Monitoring, and Evacuation Equipment**

Sample containers shall conform to the guidelines in SOP SA-6.1.

The following equipment shall be on hand when sampling groundwater wells (reference SOPs SA-6.1 and SA-7.1):

- Sample packaging and shipping equipment – Coolers for sample shipping and cooling, chemical preservatives, appropriate sampling containers and filler materials, ice, labels, and chain-of-custody documents.
- Field tools and instrumentation
  - Multi-parameter water quality meter with an in-line sample chamber capable of measuring ORP, pH, temperature, DO, specific conductance, turbidity, and salinity, or individual meters (as applicable)
  - pH Paper
  - Camera and film (if appropriate)
  - Appropriate keys (for locked wells)
  - Water level indicator and/or oil-water interface probe if separate-phase product is expected
- Pumps
  - Shallow-well pumps: Centrifugal, bladder, suction, or peristaltic pumps with drop lines and air-lift apparatus (compressor and tubing) where applicable.
  - Deep-well pumps: Submersible pump and electrical power-generating unit, or bladder pumps where applicable.
- Other sampling equipment – Bailers, graduated cylinder, stopwatch, and inert line with tripod-pulley assembly (if necessary).
- Pails – Plastic, graduated.
- Clean paper or cotton towels for cleaning equipment.
- Buckets with lids for collecting purge water.

Subject GROUNDWATER SAMPLE ACQUISITION AND ONSITE WATER QUALITY TESTING	Number SA-1.1	Page 8 of 34
	Revision 8	Effective Date 01/2012

- Decontamination solutions – Deionized water, potable water, phosphate-free laboratory-grade detergent, and analytical-grade solvent (e.g., pesticide-grade isopropanol), as required.

Ideally, sample withdrawal equipment shall be completely inert, economical, easily cleaned, cleaned prior to use, reusable, able to operate at remote sites in the absence of power sources, and capable of delivering variable rates for well purging and sample collection.

### 6.3 Calculations of Well Volume

To ensure that the proper volume of water has been removed from the well prior to sampling, it is first necessary to know the volume of standing water in the well pipe (including well screen where applicable). This volume can be easily calculated by the following method. Calculations shall be entered in the site logbook or field notebook or on a sample log sheet form or equivalent electronic form(s) (see SOP SA-6.3):

1. Obtain all available information on well construction (location, casing, screen, etc.).
2. Determine well or inner casing diameter.
3. Measure and record static water level (depth below ground level or top of casing reference point).
4. Determine depth of well by sounding using a clean, decontaminated, weighted tape measure or water level indicator.
5. Calculate number of linear feet of static water (total depth or length of well pipe minus the depth to static water level).
6. Calculate one static well volume in gallons  $V = (0.163)(T)(r^2)$

where: V = Static volume of well in gallons.  
T = Linear feet of water in the well.  
r = Inside radius of well casing in inches.  
0.163 = Conversion factor (compensates for conversion of casing radius from inches to feet and cubic feet to gallons and pi.

7. Per evacuation volumes discussed above, determine the minimum amount to be evacuated before sampling.

Measuring devices may become contaminated when gathering the above information if they are submerged in contaminated water. Decontamination of the tape or water level indicator must be conducted between measurements in different wells as follows:

1. Saturate a paper towel or clean cotton towel with deionized water.
2. As the measuring device is extracted, wipe the tape, changing the cleaning surface frequently.
3. After it is extracted, rinse the probe or tape using a spray bottle of deionized water over a bucket or similar collection container.

Based on the contaminant (oily, etc), it may be necessary to use a soap and water wash and rinse to remove contaminants. Isopropanol can be used on the probe/tape. However, it is recommended that the use of solvents on the tape be minimized because they could degrade the protective covering or possibly

Subject GROUNDWATER SAMPLE ACQUISITION AND ONSITE WATER QUALITY TESTING	Number SA-1.1	Page 9 of 34
	Revision 8	Effective Date 01/2012

remove the scale designations. If isopropanol (or some other solvent) is used, assure that the manufacturer/supplier Material Safety Data Sheet (MSDS) is obtained, kept on site at a readily available location with other MSDSs, and reviewed by personnel prior to the first usage of the solvent. Also, add the substance to the site-specific Hazardous Chemical Inventory list (see Section 5 of the TtNUS Health and Safety Guidance Manual [HSGM], Hazard Communication Program and OSHA Standard 29 CFR 1910.1200).

#### **6.4            Evacuation of Static Water – Purging**

##### **6.4.1            General**

The amount to be purged from each well will be determined prior to sample collection. This amount will depend on the intent of the monitoring program and the hydrogeologic conditions. Programs to determine overall quality of water resources may require long pumping periods to obtain a sample that is representative of a large volume of the aquifer. The pumped volume may be specified prior to sampling so that the sample can be a composite of a known volume of the aquifer. Alternately, the well can be pumped until parameters such as temperature, specific conductance, pH, and turbidity (as applicable) have stabilized. Onsite measurements of these parameters shall be recorded in the site logbook or field notebook or on standardized data sheets or an equivalent electronic form(s).

##### **6.4.2            Evacuation Devices**

The following discussion is limited to those devices commonly used at hazardous waste sites. Attachment A provides guidance on the proper evacuation device to use for given sampling situations. All of these techniques involve equipment that is portable and readily available.

##### **Bailers**

Bailers are the simplest evacuation devices used and have many advantages. They generally consist of a length of tubing equipped with a base plate and ball check-valve at the bottom. Bailers are comprised of stainless steel and plastic. They come in a variety of sizes, but the two most often used are 2 inches and 4 inches in diameter. An inert non-absorbent line such as polyethylene rope is used to lower and then raise the bailer to retrieve the sample. As the bailer is lowered into the water column, the ball is pushed up allowing the tube to be filled. When the bailer is pulled upward, the ball seats in the base plate preventing water from escaping.

Advantages of bailers include the following:

- There are few limitations on size and materials used.
- No external power source is needed.
- Bailers are inexpensive and can be dedicated and hung in a well to reduce the chances of cross-contamination.
- Bailers are relatively easy to decontaminate.

Limitations on the use of bailers include the following:

- It is time consuming to remove stagnant water using a bailer.

Subject GROUNDWATER SAMPLE ACQUISITION AND ONSITE WATER QUALITY TESTING	Number SA-1.1	Page 10 of 34
	Revision 8	Effective Date 01/2012

- Splashing the bailer into the water or transfer of sample may cause aeration.
- The use of a bailer does not permit constant in-line monitoring of groundwater parameters.
- Use of bailers is physically demanding, especially in warm temperatures at personal protection equipment (PPE) levels above Level D.

Safety concerns using a bailer include the following:

- Muscle stress and strain, especially when using 4-inch bailers and when pulling from excessively deep wells.
- Entanglement, possible hand/finger injuries, and rope burns during a sudden release of the bailer back down the well.
- Direct contact with contaminants of concern and sample preservatives when discharging the bailer contents because there is not a high level of control during a direct pour, and splashing and indirect contact with contaminants/preservatives could occur.

Control measures for these hazards are provided in Section 6.6.2.

#### Suction Pumps

There are many different types of inexpensive suction pumps including centrifugal, diaphragm, and peristaltic pumps. Centrifugal and diaphragm pumps can be used for well evacuation at a fast pumping rate and for sampling at a low pumping rate. The peristaltic pump is a low-volume pump that uses rollers to squeeze flexible tubing to create suction. This tubing can be dedicated to a well to prevent cross-contamination from well to well. Suction pumps are all portable, inexpensive, and readily available. However, because they are based on suction, their use is restricted to areas with water levels within 20 to 25 feet of the ground surface. A significant limitation is that the vacuum created by these pumps can cause loss of dissolved gases and volatile organics. Another limitation of these pumps is that they require a secondary energy source to drive them. Electrically driven pumps may require portable generators as energy sources. Air diaphragm pumps require air compressors and/or compressed gas cylinders to drive them. The advantage of the peristaltic pump is that it will operate from a portable battery source. Safety measures associated with these pumps are provided below.

#### Air-Lift and Gas-Lift Samplers

This group of pump samplers uses gas pressure either in the annulus of the well or in a venturi to force groundwater up a sampling tube. These pumps are also relatively inexpensive. Air- or gas-lift samplers are more suitable for well development than for sampling because the samples may be aerated as a result of pump action. Aeration can cause pH changes and subsequent trace metal precipitation or loss of volatile organics.

#### Submersible Pumps

Submersible pumps take in water and push the sample up a sample tube to the surface. The power sources for these samplers may be compressed gas or electricity. Operation principles vary, and displacement of the sample can be by an inflatable bladder, sliding piston, gas bubble, or impeller. Pumps are available for 2-inch-diameter wells and larger. These pumps can lift water from considerable depths (several hundred feet).



Subject GROUNDWATER SAMPLE ACQUISITION AND ONSITE WATER QUALITY TESTING	Number SA-1.1	Page 11 of 34
	Revision 8	Effective Date 01/2012

Limitations of this class of pumps include the following:

- They may have low delivery rates.
- Many models are expensive.
- Compressed gas or electric power is needed.
- Sediment in water may cause clogging of the valves or eroding of the impellers with some of these pumps.
- Decontamination of internal components can be difficult and time consuming.

#### Compressed Gases

Safety concerns using compressed gases as an energy source in these pumps are numerous. The nitrogen gas or compressed air is provided in a compressed gas cylinder at a pressure of approximately 2,000 psi. If damaged, these cylinders can become dangerous projectiles. Additionally, a sudden release of a cylinder's contents can involve considerable force that could cause significant damage to the eyes and/or skin. Protective measures include the following:

- Always wear safety impact glasses when handling compressed gases.
- Always administer compressed gases through an appropriate pressure-reducing regulator.
- When clearing the cylinder connection port, open the cylinder valve only enough to clear foreign debris. During this process, always position the cylinder valve so that it faces away from you and others.
- If the cylinder is designed to accept a valve protection cap, always keep that protection cap in place, except the cylinder is connected for use.
- When using the cylinder, lay the cylinder on its side to avoid the potential of it falling and knocking the valve off (and becoming a missile).
- DO NOT use the compressed nitrogen or air to clean clothing or to spray off the skin. Small cuts in the protective layer of the skin may permit the gas to enter into the bloodstream, presenting the potential danger of an embolism.

See the project-specific HASP for additional direction concerning cylinder safe handling procedures pertaining to the safe handling, transportation, and storage of compressed gas cylinders.

#### Electrical Shock

Even in situations where portable batteries are used, the potential for electrical shock exists. This potential risk is increased in groundwater sampling activities because of the presence of groundwater near the batteries. This potential is also increased in (prohibited) situations where jury-rigging of electrical connections is performed. Other potential hazards occur when field samplers open the hood of a running car to access the battery as a power source. To control these hazards:

Subject GROUNDWATER SAMPLE ACQUISITION AND ONSITE WATER QUALITY TESTING	Number SA-1.1	Page 12 of 34
	Revision 8	Effective Date 01/2012

- If you are unfamiliar with electrical devices, do not experiment, get help, and get the proper equipment necessary to power your device.
- Use the proper portable power inverters for cigarette lighter connections to minimize the need to access the battery under the hood of your vehicle.
- Use of electrical generators may pose a number of hazards including noise, those associated with fueling, and indirect sample influence.

To minimize or eliminate electrical generator hazards:

- Inspect the generator before use. Ensure that the generator and any extension cords are rated for the intended operation and have a Ground Fault Circuit Interrupter (GFCI) in line to control potential electrical shock.
- Fuel the generator before purging and sampling to avoid loss of power during sampling.
- Fuel engines only when they are turned OFF and have cooled sufficiently to prevent a fire hazard.
- Place the generator and any fuel source at least 50 feet from the well to be sampled to avoid indirect influence to the sample from fuel vapors or emission gases.

#### Lifting Hazards

This hazard may be experienced when moving containers of purge water, equipment, cylinders, etc. To control these potential hazards:

- Do not fill purge buckets to more than 80 percent of their capacity.
- Obtain a gas cylinder of sufficient size to complete the designated task but not too large to handle. K-size cylinders weigh approximately 135 pounds and are difficult to handle. M-size cylinders weigh approximately 50 pounds and are easier to handle and move.
- When necessary, get help lifting and moving gas cylinders and other heavy objects. Minimize twisting and turning while lifting. If it is necessary to move these cylinders or generators over significant distance, use mechanical means (carts, etc.).
- Use proper lifting techniques as described in Section 4.4 of the HSGM.

### 6.5 Onsite Water Quality Testing

This section describes the procedures and equipment required to measure the following parameters of an aqueous sample in the field:

- pH
- Specific conductance
- Temperature
- DO
- ORP
- Turbidity
- Salinity

Subject <b>GROUNDWATER SAMPLE ACQUISITION AND ONSITE WATER QUALITY TESTING</b>	Number <b>SA-1.1</b>	Page <b>13 of 34</b>
	Revision <b>8</b>	Effective Date <b>01/2012</b>

This section is applicable for use in an onsite groundwater quality monitoring program to be conducted at a hazardous or nonhazardous waste site. The procedures and equipment described are applicable to groundwater samples and are not, in general, subject to solution interferences from color, turbidity, or colloidal material or other suspended matter.

This section provides general information for measuring the parameters listed above with instruments and techniques in common use. Because instruments from different manufacturers may vary, review of the manufacturer's literature pertaining to the use of a specific instrument is required before use. Most meters used to measure field parameters require calibration on a daily basis. Refer to SOP SA-6.3 for an example equipment calibration log.

### **6.5.1 Measurement of pH**

#### **6.5.1.1 General**

Measurement of pH is one of the most important and frequently used tests in water chemistry. Practically every phase of water supply and wastewater treatment such as acid-base neutralization, water softening, and corrosion control is pH dependent. Likewise, the pH of leachate can be correlated with other chemical analyses to determine the probable source of contamination. It is therefore important that reasonably accurate pH measurements be taken and recorded on the groundwater sample log sheet (Attachment B) or equivalent electronic form.

Two methods are given for pH measurement: the pH meter and pH indicator paper. Indicator paper is used when only an approximation of the pH is required or when pH meter readings need to be verified, and the pH meter is used when a more accurate measurement is needed. The response of a pH meter can be affected by high levels of colloidal or suspended solids, but the effect is generally of little significance. Consequently, specific methods to overcome this interference are not described. The response of pH paper is unaffected by solution interferences from color, turbidity, or colloidal or suspended materials unless extremely high levels capable of coating or masking the paper are encountered. In such cases, use of a pH meter is recommended.

#### **6.5.1.2 Principles of Equipment Operation**

Use of pH papers for pH measurement relies on a chemical reaction caused by the acidity or alkalinity of the solution created by the addition of the water sample reacting with the indicator compound on the paper. Various types of pH papers are available, including litmus (for general acidity or alkalinity determination) and specific, or narrower range, pH range paper.

Use of a pH meter relies on the same principle as other ion-specific electrodes. Measurement relies on establishment of a potential difference across a glass or other type of membrane in response to (in this instance, hydrogen) ion activity (which is usually similar to concentration) across that membrane. The membrane is conductive to ionic species and, in combination with a standard or reference electrode, a potential difference proportional to the ion concentration is generated and measured.

#### **6.5.1.3 Equipment**

The following equipment is to be used for obtaining pH measurements:

- A stand-alone portable pH meter or combination meter equipped with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22).

Subject GROUNDWATER SAMPLE ACQUISITION AND ONSITE WATER QUALITY TESTING	Number SA-1.1	Page 14 of 34
	Revision 8	Effective Date 01/2012

- Combination electrode with polymer body to fit the above meter. Alternately, a pH electrode and a reference electrode can be used if the pH meter is equipped with suitable electrode inputs.
- Buffer solutions, as specified by the manufacturer. If the buffer solutions are considered hazardous per 29 Code of Federal Regulations (CFR) 1910.1200 (Hazard Communication) or the volumes used are greater than consumer commodity levels, the SSO shall obtain MSDSs from the manufacturer for the specific buffer solutions (see Section 4 of the HSGM regarding the Hazard Communication Program)
- pH indicator paper to cover the pH range 2 through 12.
- Manufacturer's operation manual. All personnel must be familiar with the equipment operation to ensure that the integrity of samples is preserved and that the equipment is operated safely.

#### 6.5.1.4 Measurement Techniques for Field Determination of pH

##### pH Meter

The following procedure shall be used for measuring pH with a pH meter (meter standardization is according to manufacturer's instructions):

1. Inspect the instrument and batteries prior to initiation of the field effort.
2. Check the integrity of the buffer solutions used for field calibration. Buffer solutions need to be changed often as a result of degradation upon exposure to the atmosphere.
3. If applicable, make sure all electrolyte solutions within the electrode(s) are at their proper levels and that no air bubbles are present within the electrode(s).
4. Calibrate the meter and electrode(s) on a daily use basis (or as recommended by manufacturer) following manufacturer's instructions. Record calibration data on a water quality meter calibration log sheet (Attachment C) or equivalent electronic form.
5. Immerse the electrode(s) in the sample. Stabilization may take several seconds to minutes. If the pH continues to drift, the sample temperature may not be stable, a physical reaction (e.g., degassing) may be taking place in the sample, or the meter or electrode may be malfunctioning. The failure of the measurements to stabilize must be clearly noted in the logbook or equivalent electronic form.
6. Read and record the pH of the sample. pH shall be recorded to the nearest 0.01 pH standard unit. Also record the sample temperature (unless otherwise specified in the SAP, record temperatures to the nearest whole degree Fahrenheit or 0.5 degree Celsius).
7. Rinse the electrode(s) with deionized water.
8. Store the electrode(s) in an accordance with manufacturer's instructions when not in use.

Any visual observation of conditions that may interfere with pH measurement, such as oily materials or turbidity, shall be noted and avoided as much as possible.

Subject GROUNDWATER SAMPLE ACQUISITION AND ONSITE WATER QUALITY TESTING	Number SA-1.1	Page 15 of 34
	Revision 8	Effective Date 01/2012

## pH Paper

Use of pH paper is very simple and requires no sample preparation, standardization, etc. pH paper is available in several ranges, including wide-range (indicating approximately pH 1 to 12), mid-range (approximately pH 0 to 6, 6 to 9, 8 to 14) and narrow-range (many available, with ranges as narrow as 1.5 pH units). The appropriate range of pH paper shall be selected. If the pH is unknown the investigation shall start with wide-range paper and proceed with successively narrower range paper until the sample pH is determined. To measure the pH with pH paper:

1. Collect a small portion of sample into a clean container.
2. Dip the pH paper into this small portion of sample.
3. Compare the color of the paper to the color chart that is provided with the pH paper and read the corresponding pH from the chart.
4. Record the pH value from the chart on the sampling log sheet.
5. Discard the used pH paper as trash.
6. Discard the small volume of sample that was used for the pH measurement with the other investigative derived waste.

## 6.5.2 Measurement of Specific Conductance

### 6.5.2.1 General

Conductance provides a measure of dissolved ionic species in water and can be used to identify the direction and extent of migration of contaminants in groundwater or surface water. It can also be used as a measure of subsurface biodegradation or to indicate alternate sources of groundwater contamination.

Conductivity is a numerical expression of the ability of a water sample to carry an electric current. This value depends on the total concentration of ionized substances dissolved in the water and the temperature at which the measurement is made. The mobility of each of the various dissolved ions, their valences, and their actual and relative concentrations affect conductivity.

It is important to obtain a specific conductance measurement soon after taking a sample because temperature changes, precipitation reactions, and absorption of carbon dioxide from the air all affect specific conductance. Most conductivity meters in use today display specific conductance in units of mS/cm, which is the conductivity normalized to a temperature of 25°C. These are the required units to be recorded on the groundwater sample log field form or equivalent electronic form.

### 6.5.2.2 Principles of Equipment Operation

An aqueous system containing ions will conduct an electric current. In a direct-current field, the positive ions migrate toward the negative electrode, and the negatively charged ions migrate toward the positive electrode. Most inorganic acids, bases, and salts such as hydrochloric acid, sodium carbonate, and sodium chloride, respectively, are relatively good conductors. Conversely, organic compounds such as sucrose or benzene, which do not dissociate in aqueous solution, conduct a current very poorly if at all.

A conductance cell and a Wheatstone Bridge (for the measurement of potential difference) may be used for measurement of electrical resistance. The ratio of current applied to voltage across the cell may also

Subject <b>GROUNDWATER SAMPLE ACQUISITION AND ONSITE WATER QUALITY TESTING</b>	Number <b>SA-1.1</b>	Page <b>16 of 34</b>
	Revision <b>8</b>	Effective Date <b>01/2012</b>

be used as a measure of conductance. The core element of the apparatus is the conductivity cell containing the solution of interest. Depending on the ionic strength of the aqueous solution to be tested, a potential difference is developed across the cell, which can be converted directly or indirectly (depending on instrument type) to a measurement of specific conductance.

#### 6.5.2.3 Equipment

The following equipment is needed for taking specific conductance measurements:

- Stand-alone portable conductivity meter or combination meter equipped with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22).
- Calibration solution, as specified by the manufacturer.
- Manufacturer's operation manual.

A variety of conductivity meters are available that may also be used to monitor salinity and temperature. Probe types and cable lengths vary, so equipment must be obtained to meet the specific requirements of the sampling program.

#### 6.5.2.4 Measurement Techniques for Specific Conductance

The steps involved in taking specific conductance measurements are as follows (calibration shall be conducted according to manufacturer's instructions):

1. Check batteries and calibrate instrument before going into the field.
2. Calibrate on a daily use basis (or as recommended by manufacturer), according to the manufacturer's instructions and record all pertinent information on a water quality meter calibration log sheet or equivalent electronic form. Potassium chloride solutions with a specific conductance closest to the values expected in the field shall be used for calibration.
3. Rinse the cell with one or more portions of the sample to be tested or with deionized water and shake excess water from the cell.
4. Immerse the electrode in the sample and measure the conductivity.
5. Read and record the results in a field logbook or on a sample log sheet or equivalent electronic form.
6. Rinse the electrode with deionized water.

If the specific conductance measurements become erratic, recalibrate the instrument and see the manufacturer's instructions for troubleshooting assistance.

### 6.5.3 Measurement of Temperature

#### 6.5.3.1 General

In combination with other parameters, temperature can be a useful indicator of the likelihood of biological action in a water sample. It can also be used to trace the flow direction of contaminated groundwater. Temperature measurements shall be taken in situ, or as quickly as possible in the field because collected water samples may rapidly equilibrate with the temperature of their surroundings.

Subject GROUNDWATER SAMPLE ACQUISITION AND ONSITE WATER QUALITY TESTING	Number SA-1.1	Page 17 of 34
	Revision 8	Effective Date 01/2012

#### 6.5.3.2 Equipment

Temperature measurements may be taken with alcohol-toluene, mercury-filled, dial-type thermometers or combination meters equipped with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22). In addition, various meters such as specific conductance or DO meters that have temperature measurement capabilities may also be used. Using such instrumentation along with suitable probes and cables, in-situ measurements of temperature at great depths can be performed.

#### 6.5.3.3 Measurement Techniques for Water Temperature

If a thermometer is used to determine the temperature for a water sample, use the following procedure:

1. Immerse the thermometer in the sample until temperature equilibrium is obtained (1 to 3 minutes). To avoid the possibility of cross-contamination, the thermometer shall not be inserted into samples that will undergo subsequent chemical analysis.
2. Record values in a field logbook or on a sample log sheet or equivalent electronic form.

If a temperature meter or probe is used:

1. Calibrate the instrument according to manufacturer's recommendations prior to use.
2. Immerse the meter/probe in the sample until temperature equilibrium is obtained (1 to 3 minutes). To avoid the possibility of cross-contamination, the meter/probe shall not be inserted into samples that will undergo subsequent chemical analysis.
3. Record values in a field logbook or on a sample log sheet or equivalent electronic form.

### 6.5.4 Measurement of Dissolved Oxygen

#### 6.5.4.1 General

DO levels in natural water and wastewater depend on the physical, chemical and biochemical activities in the water body. In addition, the growth of many aquatic organisms and the rate of corrosivity are dependent on DO concentrations. Thus, analysis for DO is a key test in water pollution and waste treatment process control. If at all possible, DO measurements shall be taken in situ because concentrations may show a large change in a short time if the sample is not adequately preserved.

The monitoring method discussed herein is limited to the use of DO meters. Chemical methods of analysis (i.e., Winkler methods) are available but require more equipment and greater sample manipulation. Furthermore, DO meters using a membrane electrode are suitable for highly polluted waters because the probe is completely submersible and is not susceptible to interference caused by color, turbidity, or colloidal material or suspended matter.

#### 6.5.4.2 Principles of Equipment Operation

DO probes are normally electrochemical cells that have two solid metal electrodes of different nobility immersed in an electrolyte. The electrolyte is retained by an oxygen-permeable membrane. The metal of highest nobility (the cathode) is positioned at the membrane. When a suitable potential exists between the two metals, reduction of oxygen to hydroxide ion (OH<sup>-</sup>) occurs at the cathode surface. An electrical

Subject GROUNDWATER SAMPLE ACQUISITION AND ONSITE WATER QUALITY TESTING	Number SA-1.1	Page 18 of 34
	Revision 8	Effective Date 01/2012

current is developed that is directly proportional to the rate of arrival of oxygen molecules at the cathode. This rate is proportional to the oxygen concentration in the water being measured.

Because the current produced in the probe is directly proportional to the rate of arrival of oxygen at the cathode, it is important that a fresh supply of sample always be in contact with the membrane. Otherwise, the oxygen in the aqueous layer along the membrane is quickly depleted and false low readings are obtained. It is therefore necessary to stir the sample (or the probe) constantly to maintain fresh solution near the membrane interface. Stirring, however, shall not be so vigorous that additional oxygen is introduced through the air-water interface at the sample surface. To avoid this possibility, some probes are equipped with stirrers to agitate the solution near the probe, leaving the surface of the solution undisturbed.

DO probes are relatively unaffected by interferences. Interferences that can occur are reactions with oxidizing gases such as chlorine or with gases such as hydrogen sulfide that are not easily depolarized from the indicating electrode. If a gaseous interference is suspected, it shall be noted in the field logbook and checked if possible. Temperature variations can also cause interference because probes exhibit temperature sensitivity. Automatic temperature compensation is normally provided by the manufacturer. This compensation can counteract some of the temperature effects but not all of them.

#### 6.5.4.3 Equipment

The following equipment is needed to measure DO concentrations:

- A stand-alone portable DO meter or combination meter equipped with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22).
- Sufficient cable to allow the probe to contact the sample.
- Manufacturer's operation manual.

#### 6.5.4.4 Measurement Techniques for Dissolved Oxygen Determination

DO probes differ as to instructions for use. Follow the manufacturer's instructions to obtain an accurate reading. The following general steps shall be used to measure DO concentrations:

1. Check the DO meter batteries before going to the field.
2. Condition the probe in a water sample for as long a period as practical before use in the field. Long periods of dry storage followed by short periods of use in the field may result in inaccurate readings.
3. Calibrate the instrument in the field according to manufacturer's recommendations or in a freshly air-saturated water sample of known temperature.
4. Record all pertinent information on a water quality meter calibration log sheet or equivalent electronic form.
5. Rinse the probe with deionized water.
6. Immerse the probe in the sample. Be sure to provide for sufficient flow past the membrane by stirring the sample. Probes without stirrers placed in wells may be moved up and down to achieve the required mixing.



Subject GROUNDWATER SAMPLE ACQUISITION AND ONSITE WATER QUALITY TESTING	Number SA-1.1	Page 19 of 34
	Revision 8	Effective Date 01/2012

7. Record the DO content and temperature of the sample in a field logbook or on a sample log sheet or equivalent electronic form.
8. Rinse the probe with deionized water.
9. Recalibrate the probe when the membrane is replaced, or as needed. Follow the manufacturer's instructions.

Note that in-situ placement of the probe is preferable because sample handling is not involved. This however may not always be practical.

Special care shall be taken during sample collection to avoid turbulence that can lead to increased oxygen solubilization and positive test interferences.

### **6.5.5 Measurement of Oxidation-Reduction Potential**

#### **6.5.5.1 General**

ORP provides a measure of the tendency of organic or inorganic chemicals to exist in an oxidized state. The ORP parameter therefore provides evidence of the likelihood of anaerobic degradation of biodegradable organics or the ratio of activities of reduced to oxidized species in the sample.

#### **6.5.5.2 Principles of Equipment Operation**

When an inert metal electrode, such as platinum, is immersed in a solution, a potential is developed at that electrode depending on the ions present in the solution. If a reference electrode is placed in the same solution, an ORP electrode pair is established. This electrode pair allows the potential difference between the two electrodes to be measured and is dependent on the concentration of the ions in solution. By this measurement, the ability to oxidize or reduce species in solution may be determined. Supplemental measurements, such as DO, may be correlated with ORP to provide knowledge of the quality of the solution, water, or wastewater.

#### **6.5.5.3 Equipment**

The following equipment is needed for measuring the ORP of a solution:

- A combination meter with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22).
- Reference solution as specified by the manufacturer.
- Manufacturer's operation manual.

#### **6.5.5.4 Measurement Techniques for Oxidation-Reduction Potential**

The following procedure is used for measuring ORP:

1. Check the equipment using the manufacturer's recommended reference solution and check its batteries before going to the field.
2. Thoroughly rinse the electrode with deionized water.

Subject <b>GROUNDWATER SAMPLE ACQUISITION AND ONSITE WATER QUALITY TESTING</b>	Number <b>SA-1.1</b>	Page <b>20 of 34</b>
	Revision <b>8</b>	Effective Date <b>01/2012</b>

3. If the probe does not respond properly to the recommended reference solution, verify the sensitivity of the electrodes by noting the change in millivolts when the pH of a test solution is altered. The ORP will increase when the pH of a test solution decreases, and the ORP will decrease when the test solution pH is increased. Place the sample in a clean container and agitate the sample. Insert the electrodes and note that the ORP drops sharply when the caustic is added (i.e., pH increases) thus indicating that the electrodes are sensitive and operating properly. If the ORP increases sharply when the caustic is added, the polarity is reversed and must be corrected in accordance with the manufacturer's instructions or the probe should be replaced.
4. Record all pertinent information on a water quality meter calibration log sheet or equivalent electronic form.

### **6.5.6 Measurement of Salinity**

#### **6.5.6.1 General**

Salinity is a unitless property of industrial and natural waters. It is the measurement of dissolved salts in a given mass of solution. Most field meters determine salinity automatically from conductivity and temperature. The displayed value will be displayed in either parts per thousand (ppt) or percent (e.g., 35 ppt equals 3.5 percent).

#### **6.5.6.2 Principles of Equipment Operation**

Salinity is determined automatically from the meter's conductivity and temperature readings according to algorithms (such as are found in Standard Methods for the Examination of Water and Wastewater). Depending on the meter, the results are displayed in either ppt or percent. The salinity measurements are carried out in reference to the conductivity of standard seawater (corrected to salinity = 35 ppt).

#### **6.5.6.3 Equipment**

The following equipment is needed for salinity measurements:

- A multi-parameter water quality meter capable of measuring conductivity and temperature and converting them to salinity (e.g., Horiba U-22 or YSI 600 series).
- Calibration solution as specified by the manufacturer.
- Manufacturer's operation manual.

#### **6.5.6.4 Measurement Techniques for Salinity**

The steps involved in taking salinity measurements are as follows (standardization shall be conducted according to manufacturer's instructions):

1. Check the expiration date of the solutions used for field calibration and replace them if they are expired.
2. Check batteries and calibrate the meter before going into the field.

Subject GROUNDWATER SAMPLE ACQUISITION AND ONSITE WATER QUALITY TESTING	Number SA-1.1	Page 21 of 34
	Revision 8	Effective Date 01/2012

3. Calibrate on a daily use basis, according to the manufacturer's instructions and record all pertinent information on a water quality meter calibration log sheet or equivalent electronic form.
4. Rinse the cell with the sample to be tested. This is typically accomplished as the probe is placed in line during the collection of the purge water up to the time of sample acquisition.
5. Immerse the multi-probe in the sample and measure the salinity. Read and record the results in a field logbook or on a sample log sheet or equivalent electronic form.
6. Rinse the probes with deionized water.

### **6.5.7 Measurement of Turbidity**

#### **6.5.7.1 General**

Turbidity is an expression of the optical property that causes light to be scattered and absorbed rather than transmitted in a straight line through the sample. Turbidity in water is caused by suspended matter such as clay, silt, or other finely divided organic and inorganic matter and microscopic organisms including plankton.

It is important to obtain a turbidity reading immediately after taking a sample because irreversible changes in turbidity may occur if the sample is stored too long.

#### **6.5.7.2 Principles of Equipment Operation**

Turbidity is measured by the Nephelometric Method, which is based on a comparison of the intensity of light scattered by the sample under defined conditions with the intensity of light scattered by a standard reference suspension under the same conditions. The higher the scattered light intensity, the higher the turbidity.

Formazin polymer is used as the reference turbidity standard suspension because of its ease of preparation combined with a higher reproducibility of its light-scattering properties than clay or turbid natural water. The turbidity of a specified concentration of formazin suspension is defined as 40 nephelometric units. This same suspension has an approximate turbidity of 40 Jackson units when measured on the candle turbidimeter. Therefore, nephelometric turbidity units (NTUs) based on the formazin preparation will approximate units derived from the candle turbidimeter but will not be identical to them.

#### **6.5.7.3 Equipment**

The following equipment is needed for turbidity measurements:

- A turbidity meter (e.g., LaMotte 2020) that calibrates easily using test cells with standards of 0.0, 1.0, and 10 NTUs, or a combination meter equipped with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22).
- Calibration solution and sample tubes, as specified by the manufacturer.
- Manufacturer's operation manual.

Subject GROUNDWATER SAMPLE ACQUISITION AND ONSITE WATER QUALITY TESTING	Number SA-1.1	Page 22 of 34
	Revision 8	Effective Date 01/2012

#### 6.5.7.4 Measurement Techniques for Turbidity

The steps involved in taking turbidity measurements utilizing an electrode (e) or light meter (l) are listed below (standardization shall be done according to manufacturer's instructions):

1. Check the expiration date of the solutions used for field calibration and replace them if they are expired.
2. Check batteries and calibrate the instrument before going into the field.
3. Calibrate on a daily basis according to the manufacturer's instructions, and record all pertinent information on a turbidity meter calibration log sheet (Attachment C) or equivalent electronic form.
4. When using the YSI and/or Horiba U-22, rinse the electrode with one or more portions of the sample to be tested or with deionized water.
5. When using the Lamotte 2020, fill the light meter's glass test cell with approximately 5 mL of sample, screw on the cap, wipe off glass to remove all residue that could intercept the instrument's light beam, place the test cell in the light meter, and close the lid.
6. Immerse the electrode in the sample and measure the turbidity.
7. The reading must be taken immediately because suspended solids will settle over time resulting in a lower, inaccurate turbidity reading.
8. Read and record the results in a field logbook or on a sample log sheet or equivalent electronic form. Include a physical description of the sample, including color, qualitative estimate of turbidity, etc.
9. Rinse the electrode or test cell with deionized water.

### 6.6 Sampling

#### 6.6.1 Sampling Plan

The sampling approach consisting of the following shall be developed as part of the project planning documents approved prior to beginning work in the field:

- Background and objectives of sampling.
- Brief description of area and waste characterization.
- Identification of sampling locations, with map or sketch, and applicable well construction data (well size, depth, screened interval, reference elevation).
- Intended number, sequence, volumes, and types of samples. If the relative degree of contamination between wells is insignificant, a sampling sequence that facilitates sampling logistics may be followed. Where some wells are known or strongly suspected of being highly contaminated, these shall be sampled last to reduce the risk of cross-contamination between wells. In situations where the well is not well-characterized and the nature or extent of airborne contamination is unknown, it is recommended that head space analysis using a photoionization detector (PID) or flame ionization detector (FID) is performed to rate the wells, sampling from least contaminated to most contaminated.

Subject GROUNDWATER SAMPLE ACQUISITION AND ONSITE WATER QUALITY TESTING	Number SA-1.1	Page 23 of 34
	Revision 8	Effective Date 01/2012

Refer to the project-specific HASP for appropriate information and direction on air monitoring requirements.

- Sample preservation requirements.
- Work schedule.
- List of team members.
- List of observers and contacts.
- Other information, such as the necessity for a warrant or permission of entry, requirements for split samples, access problems, location of keys, etc.
- The FOL shall ensure that the sampling method(s) to be employed is accurately represented in the HASP, indicating the types of sampling to be employed and the hazards. If the methods are not accurately represented, the FOL should rectify this with the HASP author.
- The FOL shall ensure that sampling teams understand the sampling approach that they are to follow. Where sampling teams are made up of personnel from multiple locations, personal sampling experiences may vary. Therefore the FOL shall review project-specific requirements, SOPs, and protocol to be followed. The FOL will conduct periodic surveys to ensure that these methods are being completed per his/her direction.

#### **6.6.2 Sampling Methods as Related to Low-Flow Sampling**

The collection of a groundwater sample consists of the following steps:

1. Ensure the safety of the sample location. Take a few minutes to evaluate the area for physical hazards (trip hazards, uneven ground, overhanging branches, etc.) and natural hazards (snakes, bees, spiders, etc.) that may exist in the area or that may have constructed nests in the well head. Snakes often like to sun themselves on concrete well pads. Follow provisions in the project-specific HASP and/or HSGM for addressing natural hazards.
2. As indicated earlier, some monitoring wells have the potential to contain pressurized headspace (e.g., through the generation of gases from contaminated groundwater, due to biological processes, degradation of contaminants, or simply based on location such as near a landfill or in areas that intersect lithological abnormalities) or through intentional artificial means such as those associated with air sparging systems. Injection or extraction wells may be artificially pressurized and may remain so for several days after the system has been turned off. This presents a hazard to people opening these wells. The Field Sampling Technician shall employ the following practices to minimize these hazards:
  - Wear safety glasses to protect the eyes. If site-specific observations and conditions indicate that the wells may be pressurized, wear a full-face shield over the safety impact eye protection.
  - DO NOT place your face or any other part of your body over the well when opening because this may place you in a strike zone.
  - Open the well cover at arms length, then step away and allow the well to off gas and stabilize.

Follow directions provided in the project-specific HASP, Work Plan and/or Sampling Plan pertaining to the use of volatile chemical detection equipment (PID or FID) within the breathing zone of the

Subject GROUNDWATER SAMPLE ACQUISITION AND ONSITE WATER QUALITY TESTING	Number SA-1.1	Page 24 of 34
	Revision 8	Effective Date 01/2012

sampler during sampling to determine the need to retreat from the work area and/or for the use of respiratory protection (as specified in the HASP).

3. When proper respiratory protection has been donned, sound the well for total depth and water level (using clean equipment) and record these data on a groundwater sampling log sheet or equivalent electronic form; then calculate the fluid volume in the well pipe (as previously described in this SOP). It is imperative that downhole equipment be adequately decontaminated between wells to prevent cross-contamination. Just as sampling occurs from the least contaminated to the most contaminated, it is also recommended that groundwater level measurements be taken in this manner.
4. Calculate volume of well water to be removed as described in Section 6.3.
5. Select the appropriate purging equipment (see Attachment A to this SOP) or as designated within your Work Plan/Sampling Plan. If an electric submersible pump with packer is chosen, go to Step 10.
6. Lower the purging equipment or intake into the well to a short distance below the water level or mid-screen as indicated in project-specific documentation and begin water removal. Remember that some contaminants are "bottom dwellers," and in these cases, project-specific direction may specify placing the intake just above (1 to 2 feet) the well bottom. Secure the pump intake at the well and secure the effluent at the collection container and begin pumping. The pumping rate will be determined based on the decrease in the water level (see Section 6.7) or as directed in your project-specific documents or this SOP. Purge water is generally collected in a 5-gallon bucket or similar open- or closed-top container. To minimize the potential for spills and back injuries, do not fill 5-gallon buckets beyond approximately 80 percent of their capacity. Dispose of purge water as indicated in the planning document(s). Where necessary, slow the pumping rate or lower the pump intake as required to maintain submergence.
7. Estimate the approximate rate of discharge frequently and record it on the Low Flow Purge Data Sheet (see Attachment D). Estimate flow rate by noting the amount of discharge in a bucket or graduated cylinder per unit time using a watch with a second hand or a stopwatch.
8. Observe the peristaltic pump tubing intake for degassing "bubbles." If bubbles are abundant and the intake is fully submerged, this pump is not suitable for collecting samples for volatile organics.
9. Purge a minimum of three to five casing volumes before sampling (or as directed by the site-specific SAP). In low-permeability strata (i.e., if the well is pumped to dryness), one volume will suffice. Allow the well to recover to 75 percent of initial water level before sampling. Do not overfill purge containers because this increases the potential for spills and lifting injuries.
10. If sampling using a submersible pump, lower the pump intake to mid-screen (or the middle of the open section in uncased wells) and collect the sample. If sampling with a bailer, lower the bailer to just below the water surface.
11. For pump and packer assemblies only: Lower the assembly into the well so that the packer is positioned just above the screen or open section. Inflate the packer. Purge a volume equal to at least twice the screened interval (or unscreened open section volume below the packer) before sampling. Packers shall always be tested in a casing section above ground to determine proper inflation pressures for good sealing.
12. If the recovery time of the well is very slow (e.g., 24 hours or greater), sample collection can be delayed until the following day. If the well has been purged early in the morning, sufficient water may be standing in the well by the day's end to permit sample collection. If the well is incapable of producing a sufficient volume of sample at any time, take the largest quantity available and record

Subject GROUNDWATER SAMPLE ACQUISITION AND ONSITE WATER QUALITY TESTING	Number SA-1.1	Page 25 of 34
	Revision 8	Effective Date 01/2012

this occurrence in the site logbook or equivalent electronic form. When this occurs, contact the analytical laboratory to alert them that a reduced sample volume(s) will be submitted for analysis.

13. Fill sample containers and preserve and label them as described in SOP SA-6.1. Many sample bottles will contain preservative when they are shipped to the field. In those cases, do not add preservative.
14. Replace the well cap and lock it as appropriate. Make sure the well is readily identifiable as the source of the sample.
15. Process sample containers as described in SOP SA-6.1.
16. Decontaminate equipment as described in SOP SA-7.1.

## **6.7 Low-Flow Purging and Sampling**

### **6.7.1 Scope and Application**

Low-flow purging and sampling techniques may be required for groundwater sampling activities. The purpose of low-flow purging and sampling is to collect groundwater samples that contain "representative" amounts of mobile organic and inorganic constituents in the vicinity of the selected open well interval, at or near natural flow conditions. This minimum-stress procedure emphasizes negligible water level drawdown and low pumping rates to collect samples with minimal alterations in water chemistry. This procedure is designed primarily to be used in wells with a casing diameter of 1 inch or more and a saturated screen length, or open interval, of 10 feet or less. Samples obtained are suitable for analyses of common types of groundwater contaminants (volatile and semivolatile organic compounds, pesticides, polychlorinated biphenyls [PCBs], metals and other inorganic ions [cyanide, chloride, sulfate, etc.]). This low-flow procedure is not designed for collection of non-aqueous phase liquid samples from wells containing light or dense non-aqueous phase liquids (LNAPLs or DNAPLs).

This procedure is flexible for various well construction types and groundwater yields. The goal of the procedure is to obtain a turbidity level of less than 10 NTUs and to achieve a water level drawdown of less than 0.3 foot during purging and sampling. If these goals cannot be achieved, sample collection can take place provided that the remaining criteria in this procedure are met.

### **6.7.2 Equipment**

The following equipment is required (as applicable) for low-flow purging and sampling:

- Adjustable rate submersible pump (e.g., centrifugal or bladder pump constructed of stainless steel or Teflon).
- Disposable clear plastic bottom-filling bailers to be used to check for and obtain samples of LNAPLs or DNAPLs.
- Tubing – Teflon, Teflon-lined polyethylene, polyethylene, polyvinyl chloride (PVC), Tygon, or stainless steel tubing can be used to collect samples for analysis, depending on the analyses to be performed and regulatory requirements.
- Water level measuring device with 0.01-foot accuracy (electronic devices are preferred for tracking water level drawdown during all pumping operations).

Subject GROUNDWATER SAMPLE ACQUISITION AND ONSITE WATER QUALITY TESTING	Number SA-1.1	Page 26 of 34
	Revision 8	Effective Date 01/2012

- Interface probe.
- Flow measurement supplies.
- Power source (generator, nitrogen tank, etc.). If a gasoline generator is used, it must be located downwind and at a safe distance from the well so that the exhaust fumes do not contaminate the samples.
- Indicator parameter monitoring instruments – pH, turbidity, specific conductance, and temperature. Use of a flow-through cell is recommended. Optional indicators - ORP, salinity, and DO. A flow-through cell (also referred to as an in-line sample chamber) is required.
- Standards to perform field calibration of instruments.
- Decontamination supplies.
- Logbook(s) and other forms (see Attachments B through D) or equivalent electronic form(s).
- Sample bottles.
- Sample preservation supplies (as required by the analytical methods).
- Sample tags and/or labels.
- Well construction data, location map, field data from last sampling event (if available).
- Field Sampling Plan.
- PID or FID instrument for measuring volatile organic compounds (VOCs) per the HASP.

### **6.7.3 Purging and Sampling Procedure**

1. Open the monitoring well as stated earlier and step away. Prepare sampling equipment while allowing 3 to 5 minutes to allow the water level to reach equilibrium. In situations where VOCs are the primary contaminants of concern, air monitoring of the samplers' breathing zone areas may be required by the HASP (typically with a PID or FID).
2. Measure the water level immediately prior to placing the pump in the well and record the water level on the Low-Flow Purge Data Form or equivalent electronic form immediately prior to placing the pump or tubing into the well.
3. Lower the measuring device further into the well to collect the total depth measurement. Again wait 3 to 5 minutes to allow the well to equilibrate to the initial water level prior to placing the pump or pump intake in the well.
4. Record the total well depth on the Low-Flow Purge Data Form or equivalent electronic form immediately prior to placing the pump or tubing into the well
5. Lower the pump or tubing slowly into the well so that the pump intake is located at the center of the saturated screen length of the well. If possible, keep the pump intake at least 2 feet above the bottom of the well to minimize mobilization of sediment that may be present in the bottom of the well. Collection of turbidity-free water samples may be difficult if there is 3 feet or less of standing water in the well.



Subject GROUNDWATER SAMPLE ACQUISITION AND ONSITE WATER QUALITY TESTING	Number SA-1.1	Page 27 of 34
	Revision 8	Effective Date 01/2012

6. Start with the initial pump rate set at approximately 0.1 liter per minute. Use a graduated cylinder and stopwatch to measure the pumping rate. Adjust the pumping rates as necessary to prevent drawdown from exceeding 0.3 foot during purging. If no drawdown is noted, the pump rate may be increased (to a maximum of 0.4 liter per minute) to expedite the purging and sampling event. The pump rate will be reduced if turbidity is greater than 10 NTUs after all other field parameters have stabilized. If groundwater is drawn down below the top of the well screen, purging shall cease or the well shall be pumped to dryness and then allowed to recover before purging continues. Well recovery to 75 percent is necessary prior to sampling. Slow-recovering wells should be identified and purged at the beginning of the workday to maximize field work efficiency. If possible, samples should be collected from these wells within the same workday and no later than 24 hours after the end of purging.
  7. Measure the water level in the well every 5 to 10 minutes using the water level meter. Record the well water level on the Low Flow Purge Data Form (Attachment D) or equivalent electronic form.
  8. Record on the Low Flow Purge Data Form every 5 to 10 minutes the water quality parameters (pH, specific conductance, temperature, turbidity, ORP, DO, and salinity or as specified by the approved site-specific planning document) measured by the water quality meter and turbidity meter. If the cell needs to be cleaned during purging operations, continue pumping (allow the pump to discharge into a container) and disconnect the cell. Rinse the cell with distilled/deionized water. After cleaning is completed, reconnect the flow-through cell and continue purging. Document the cell cleaning on the Low-Flow Purge Data Form or equivalent electronic form.
  9. Estimate the flow rate by noting the amount of discharge in a graduated cylinder per unit time using a watch with a second hand. Remeasure the flow rate any time the pump rate is adjusted and periodically during purging. This will determine if a reduction in rate has occurred due to possible battery depletion.
  10. During purging, check for the presence of bubbles in the flow-through cell. The presence of bubbles is an indication that connections are not tight. If bubbles are observed, check for loose connections and tighten, repair, or replace them as necessary to achieve a tight connection.
  11. Wait until stabilization is achieved, or a minimum of two saturated screen volumes have been removed and three consecutive readings, taken at 5 to 10 minute intervals, are within the following limits, then begin sampling:
    - pH  $\pm 0.2$  standard units
    - Specific conductance  $\pm 10\%$
    - Temperature  $\pm 10\%$
    - Turbidity less than 10 NTUs
    - DO  $\pm 10\%$
  12. If the above conditions have not been met after the well has been purged for 4 hours, purging will be considered complete and sampling can begin. Record the final well stabilization parameters from the Low-Flow Purge Data Form onto the Groundwater Sample Log Form or equivalent electronic form.
- NOTE:** VOC samples are preferably collected first, directly into pre-preserved sample containers. Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.
13. If the water column in the pump tubing collapses (water does not completely fill the tubing) before exiting the tubing, use one of the following procedures to collect VOC samples:

Subject GROUNDWATER SAMPLE ACQUISITION AND ONSITE WATER QUALITY TESTING	Number SA-1.1	Page 28 of 34
	Revision 8	Effective Date 01/2012

- Collect samples for non-VOC analyses first, then increase the flow rate incrementally until the water column completely fills the tubing, collect the sample for VOCs, and record the new flow rate.
- Reduce the diameter of the existing tubing until the water column fills the tubing either by adding a connector (Teflon or stainless steel) or clamp, which should reduce the flow rate by constricting the end of the tubing. Proceed with sample collection.
- Insert a narrow-diameter Teflon tube into the pump's tubing so that the end of the tubing is in the water column and the other end of the tubing protrudes beyond the pump's tubing, then collect the sample from the narrow diameter tubing.
- Prepare samples for shipping as per SOP SA-6.1.

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Subject <b>GROUNDWATER SAMPLE ACQUISITION AND ONSITE WATER QUALITY TESTING</b>	Number <b>SA-1.1</b>	Page <b>29 of 34</b>
	Revision <b>8</b>	Effective Date <b>01/2012</b>

**ATTACHMENT A**  
**PURGING EQUIPMENT SELECTION**

Diameter Casing		Bailer	Peristaltic Pump	Vacuum Pump	Air-lift	Diaphragm "Trash" Pump	Submersible Diaphragm Pump	Submersible Electric Pump	Submersible Electric Pump w/Packer
1.25-Inch	Water level <25 feet	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>			
	Water Level >25 feet	<b>X</b>			<b>X</b>				
2-Inch	Water level <25 feet	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>		
	Water Level >25 feet	<b>X</b>			<b>X</b>		<b>X</b>		
4-Inch	Water level <25 feet	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>
	Water Level >25 feet	<b>X</b>			<b>X</b>		<b>X</b>	<b>X</b>	<b>X</b>
6-Inch	Water level <25 feet				<b>X</b>	<b>X</b>		<b>X</b>	<b>X</b>
	Water Level >25 feet				<b>X</b>			<b>X</b>	<b>X</b>
8-Inch	Water level <25 feet				<b>X</b>	<b>X</b>		<b>X</b>	<b>X</b>
	Water Level >25 feet				<b>X</b>			<b>X</b>	<b>X</b>

**ATTACHMENT A**  
**PURGING EQUIPMENT SELECTION**  
**PAGE 2**

Manufacturer	Model Name/Number	Principle of Operation	Maximum Outside Diameter/L ength (Inches)	Construction Materials (w/Lines and Tubing)	Lift Range (ft)	Delivery Rates or Volumes	1982 Price (Dollars)	Comments
BarCad Systems, Inc.	BarCad Sampler	Dedicated; gas drive (positive displacement)	1.5/16	PE, brass, nylon, aluminum oxide	0-150 with std. tubing	1 liter for each 10-15 feet of submergence	\$220-350	Requires compressed gas; custom sizes and materials available; acts as piezometer.
Cole-Parmer Inst. Co.	Master Flex 7570 Portable Sampling Pump	Portable; peristaltic (suction)	<1.0/NA	(not submersible) Tygon®, silicone Viton®	0-30	670 mL/min with 7015-20 pump head	\$500-600	AC/DC; variable speed control available; other models may have different flow rates.
ECO Pump Corp.	SAMPLifier	Portable; venturi	<1.5 or <2.0/NA	PP, PE, PVC, SS, Teflon®, Tefzel®	0-100	0-500 mL/min depending on lift	\$400-700	AC, DC, or gasoline-driven motors available; must be primed.
Geltek Corp.	Bailer 219-4	Portable; grab (positive displacement)	1.66/38	Teflon®	No limit	1,075 mL	\$120-135	Other sizes available.
GeoEngineering, Inc.	GEO-MONITOR	Dedicated; gas drive (positive displacement)	1.5/16	PE, PP, PVC, Viton®	Probably 0-150	Approximately 1 liter for each 10 feet of submergence	\$185	Acts as piezometer; requires compressed gas.
Industrial and Environmental Analysts, Inc. (IEA)	Aquarius	Portable; bladder (positive displacement)	1.75/43	SS, Teflon®, Viton®	0-250	0-2,800 mL/min	\$1,500-3,000	Requires compressed gas; other models available; AC, DC, manual operation possible.
IEA	Syringe Sampler	Portable; grab (positive displacement)	1.75/43	SS, Teflon®	No limit	850 mL sample volume	\$1,100	Requires vacuum and/or pressure from hand pump.
Instrument Specialties Co. (ISCO)	Model 2600 Well Sampler	Portable; bladder (positive displacement)	1.75/50	PC, silicone, Teflon®, PP, PE, Detrin®, acetal	0-150	0-7,500 mL/min	\$990	Requires compressed gas (40 psi minimum).
Keck Geophysical Instruments, Inc.	SP-81 Submersible Sampling Pump	Portable; helical rotor (positive displacement)	1.75/25	SS, Teflon®, PP, EPDM, Viton®	0-160	0-4,500 mL/min	\$3,500	DC operated.
Leonard Mold and Die Works, Inc.	GeoFilter Small Diameter Well Pump (#0500)	Portable; bladder (positive displacement)	1.75/38	SS, Teflon®, PC, Neoprene®	0-400	0-3,500 mL/min	\$1,400-1,500	Requires compressed gas (55 psi minimum); pneumatic or AC/DC control module.
Oil Recovery Systems, Inc.	Surface Sampler	Portable; grab (positive displacement)	1.75/12	acrylic, Detrin®	No limit	Approximately 250 mL	\$125-160	Other materials and models available; for measuring thickness of "floating" contaminants.
Q.E.D. Environmental Systems, Inc.	Well Wizard® Monitoring System (P-100)	Dedicated; bladder (positive displacement)	1.66/36	PVC	0-230	0-2,000 mL/min	\$300-400	Requires compressed gas; piezometric level indicator; other materials available.

Subject GROUNDWATER SAMPLE ACQUISITION AND ONSITE WATER QUALITY TESTING	
Number SA-1.1	Page 30 of 34
Revision 8	Effective Date 01/2012

**ATTACHMENT A**  
**PURGING EQUIPMENT SELECTION**  
**PAGE 3**

Manufacturer	Model Name/Number	Principle of Operation	Maximum Outside Diameter/Length (Inches)	Construction Materials (w/Lines and Tubing)	Lift Range (ft)	Delivery Rates or Volumes	1982 Price (Dollars)	Comments
Randolph Austin Co.	Model 500 Vari-Flow Pump	Portable; peristaltic (suction)	<0.5/NA	(Not submersible) Rubber, Tygon®, or Neoprene®	0-30	See comments	\$1,200-1,300	Flow rate dependent on motor and tubing selected; AC operated; other models available.
Robert Bennett Co.	Model 180	Portable; piston (positive displacement)	1.8/22	SS, Teflon®, Delrin® PP, Viton®, acrylic, PE	0-500	0-1,800 mL/min	\$2,600-2,700	Requires compressed gas; water level indicator and flow meter; custom models available.
Slope Indicator Co. (SINCO)	Model 514124 Pneumatic Water Sampler	Portable; gas drive (positive displacement)	1.9/18	PVC, nylon	0-1,100	250 mL/flushing cycle	\$250-350	Requires compressed gas; SS available; piezometer model available; dedicated model available.
Solinst Canada Ltd.	5W Water Sampler	Portable; grab (positive displacement)	1.9/27	PVC, brass, nylon, Neoprene®	0-330	500 mL	\$1,300-1,800	Requires compressed gas; custom models available.
TIMCO Mfg. Co., Inc.	Std. Bailer	Portable; grab (positive displacement)	1.66/Custom	PVC, PP	No limit	250 mL/ft of bailer	\$20-60	Other sizes, materials, models available; optional bottom-emptying device available; no solvents used.
TIMCO	Air or Gas Lift Sampler	Portable; gas drive (positive displacement)	1.66/30	PVC, Tygon®, Teflon®	0-150	350 mL/flushing cycle	\$100-200	Requires compressed gas; other sizes, materials, models available; no solvents used.
Tole Devices Co.	Sampling Pump	Portable; bladder (positive displacement)	1.38/48	SS, silicone, Delrin®, Tygon®	0-125	0-4,000 mL/min	\$800-1,000	Compressed gas required; DC control module; custom built.

**Construction Material Abbreviations:**

PE Polyethylene  
 PP Polypropylene  
 PVC Polyvinyl chloride  
 SS Stainless steel  
 PC Polycarbonate  
 EPDM Ethylene-propylene diene (synthetic rubber)

**Other Abbreviations:**

NA Not applicable  
 AC Alternating current  
 DC Direct current

**NOTE:** Other manufacturers market pumping devices which could be used for groundwater sampling, though not expressly designed for this purpose. The list is not meant to be all-inclusive and listing does not constitute endorsement for use. Information in the table is from sales literature and/or personal communication. No skimmer, scavenger-type, or high-capacity pumps are included.

Source: Barcelona et al., 1983.

Subject  
 GROUNDWATER SAMPLE  
 ACQUISITION AND ONSITE  
 WATER QUALITY TESTING

Number  
 SA-1.1  
 Revision  
 8

Page  
 31 of 34  
 Effective Date  
 01/2012



01/2012

SERIAL NUMBER: \_\_\_\_\_

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# GROUNDWATER SAMPLE ACQUISITION AND ONSITE WATER QUALITY TESTING

SA-1.1

34 of 34

8

01/2012

## LOW FLOW PURGE DATA SHEET



WELL ID.: \_\_\_\_\_  
DATE: \_\_\_\_\_

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PAGE\_\_OF\_\_



SOP-12

**EPA SOP GW-0001**

**EPA REGION I LOW STRESS (LOW FLOW) PURGING AND SAMPLING PROCEDURE  
FOR THE COLLECTION OF GROUNDWATER SAMPLES FROM MONITORING WELLS**

## U.S. ENVIRONMENTAL PROTECTION AGENCY REGION I

### LOW STRESS (low flow) PURGING AND SAMPLING PROCEDURE FOR THE COLLECTION OF GROUNDWATER SAMPLES FROM MONITORING WELLS

Quality Assurance Unit  
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## Revision Page

[illegible]

<b>TABLE OF CONTENTS</b>	<b>Page</b>
<b>USE OF TERMS</b>	<b>4</b>
<b>SCOPE &amp; APPLICATION</b>	<b>5</b>
<b>BACKGROUND FOR IMPLEMENTATION</b>	<b>6</b>
<b>HEALTH &amp; SAFETY</b>	<b>7</b>
<b>CAUTIONS</b>	<b>7</b>
<b>PERSONNEL QUALIFICATIONS</b>	<b>9</b>
<b>EQUIPMENT AND SUPPLIES</b>	<b>9</b>
<b>EQUIPMENT/INSTRUMENT CALIBRATION</b>	<b>13</b>
<b>PRELIMINARY SITE ACTIVITIES</b>	<b>13</b>
<b>PURGING AND SAMPLING PROCEDURE</b>	<b>14</b>
<b>DECONTAMINATION</b>	<b>19</b>
<b>FIELD QUALITY CONTROL</b>	<b>21</b>
<b>FIELD LOGBOOK</b>	<b>21</b>
<b>DATA REPORT</b>	<b>22</b>
<b>REFERENCES</b>	<b>22</b>
<b>APPENDIX A PERISTALTIC PUMPS</b>	<b>24</b>
<b>APPENDIX B SUMMARY OF SAMPLING INSTRUCTIONS</b>	<b>25</b>
<b>LOW-FLOW SETUP DIAGRAM</b>	<b>29</b>
<b>APPENDIX C EXAMPLE WELL PURGING FORM</b>	<b>30</b>

## USE OF TERMS

Equipment blank: The equipment blank shall include the pump and the pump's tubing. If tubing is dedicated to the well, the equipment blank needs only to include the pump in subsequent sampling rounds. If the pump and tubing are dedicated to the well, the equipment blank is collected prior to its placement in the well. If the pump and tubing will be used to sample multiple wells, the equipment blank is normally collected after sampling from contaminated wells and not after background wells.

Field duplicates: Field duplicates are collected to determine precision of the sampling procedure. For this procedure, collect duplicate for each analyte group in consecutive order (VOC original, VOC duplicate, SVOC original, SVOC duplicate, etc.).

Indicator field parameters: This SOP uses field measurements of turbidity, dissolved oxygen, specific conductance, temperature, pH, and oxidation/reduction potential (ORP) as indicators of when purging operations are sufficient and sample collection may begin.

Matrix Spike/Matrix Spike Duplicates: Used by the laboratory in its quality assurance program. Consult the laboratory for the sample volume to be collected.

Potentiometric Surface: The level to which water rises in a tightly cased well constructed in a confined aquifer. In an unconfined aquifer, the potentiometric surface is the water table.

QAPP: Quality Assurance Project Plan

SAP: Sampling and Analysis Plan

SOP: Standard operating procedure

Stabilization: A condition that is achieved when all indicator field parameter measurements are sufficiently stable (as described in the "Monitoring Indicator Field Parameters" section) to allow sample collection to begin.

Temperature blank: A temperature blank is added to each sample cooler. The blank is measured upon receipt at the laboratory to assess whether the samples were properly cooled during transit.

Trip blank (VOCs): Trip blank is a sample of analyte-free water taken to the sampling site and returned to the laboratory. The trip blanks (one pair) are added to each sample cooler that contains VOC samples.

## SCOPE & APPLICATION

The goal of this groundwater sampling procedure is to collect water samples that reflect the total mobile organic and inorganic loads (dissolved and colloidal sized fractions) transported through the subsurface under ambient flow conditions, with minimal physical and chemical alterations from sampling operations. This standard operating procedure (SOP) for collecting groundwater samples will help ensure that the project's data quality objectives (DQOs) are met under certain low-flow conditions.

The SOP emphasizes the need to minimize hydraulic stress at the well-aquifer interface by maintaining low water-level drawdowns, and by using low pumping rates during purging and sampling operations. Indicator field parameters (e.g., dissolved oxygen, pH, etc.) are monitored during purging in order to determine when sample collection may begin. Samples properly collected using this SOP are suitable for analysis of groundwater contaminants (volatile and semi-volatile organic analytes, dissolved gases, pesticides, PCBs, metals and other inorganics), or naturally occurring analytes. This SOP is based on Puls, and Barcelona (1996).

This procedure is designed for monitoring wells with an inside diameter (1.5-inches or greater) that can accommodate a positive lift pump with a screen length or open interval ten feet or less and with a water level above the top of the screen or open interval (Hereafter, the "screen or open interval" will be referred to only as "screen interval"). This SOP is not applicable to other well-sampling conditions.

While the use of dedicated sampling equipment is not mandatory, dedicated pumps and tubing can reduce sampling costs significantly by streamlining sampling activities and thereby reducing the overall field costs.

The goal of this procedure is to emphasize the need for consistency in deploying and operating equipment while purging and sampling monitoring wells during each sampling event. This will help to minimize sampling variability.

This procedure describes a general framework for groundwater sampling. Other site specific information (hydrogeological context, conceptual site model (CSM), DQOs, etc.) coupled with systematic planning must be added to the procedure in order to develop an appropriate site specific SAP/QAPP. In addition, the site specific SAP/QAPP must identify the specific equipment that will be used to collect the groundwater samples.

This procedure does not address the collection of water or free product samples from wells containing free phase LNAPLs and/or DNAPLs (light or dense non-aqueous phase

liquids). For this type of situation, the reader may wish to check: Cohen, and Mercer (1993) or other pertinent documents.

This SOP is to be used when collecting groundwater samples from monitoring wells at all Superfund, Federal Facility and RCRA sites in Region 1 under the conditions described herein. Request for modification of this SOP, in order to better address specific situations at individual wells, must include adequate technical justification for proposed changes. All changes and modifications must be approved and included in a revised SAP/QAPP before implementation in field.

## **BACKGROUND FOR IMPLEMENTATION**

It is expected that the monitoring well screen has been properly located (both laterally and vertically) to intercept existing contaminant plume(s) or along flow paths of potential contaminant migration. Problems with inappropriate monitoring well placement or faulty/improper well installation cannot be overcome by even the best water sampling procedures. This SOP presumes that the analytes of interest are moving (or will potentially move) primarily through the more permeable zones intercepted by the screen interval.

Proper well construction, development, and operation and maintenance cannot be overemphasized. The use of installation techniques that are appropriate to the hydrogeologic setting of the site often prevent "problem well" situations from occurring. During well development, or redevelopment, tests should be conducted to determine the hydraulic characteristics of the monitoring well. The data can then be used to set the purging/sampling rate, and provide a baseline for evaluating changes in well performance and the potential need for well rehabilitation. Note: if this installation data or well history (construction and sampling) is not available or discoverable, for all wells to be sampled, efforts to build a sampling history should commence with the next sampling event.

The pump intake should be located within the screen interval and at a depth that will remain under water at all times. It is recommended that the intake depth and pumping rate remain the same for all sampling events. The mid-point or the lowest historical midpoint of the saturated screen length is often used as the location of the pump intake. For new wells, or for wells without pump intake depth information, the site's SAP/QAPP must provide clear reasons and instructions on how the pump intake depth(s) will be selected, and reason(s) for the depth(s) selected. If the depths to top and bottom of the well screen are not known, the SAP/QAPP will need to describe how the sampling depth will be determined and how the data can be used.

Stabilization of indicator field parameters is used to indicate that conditions are suitable for sampling to begin. Achievement of turbidity levels of less than 5 NTU, and stable drawdowns of less than 0.3 feet, while desirable, are not mandatory. Sample collection

may still take place provided the indicator field parameter criteria in this procedure are met. If after 2 hours of purging indicator field parameters have not stabilized, one of three optional courses of action may be taken: a) continue purging until stabilization is achieved, b) discontinue purging, do not collect any samples, and record in log book that stabilization could not be achieved (documentation must describe attempts to achieve stabilization), c) discontinue purging, collect samples and provide full explanation of attempts to achieve stabilization (note: there is a risk that the analytical data obtained, especially metals and strongly hydrophobic organic analytes, may reflect a sampling bias and therefore, the data may not meet the data quality objectives of the sampling event).

It is recommended that low-flow sampling be conducted when the air temperature is above 32°F (0°C). If the procedure is used below 32°F, special precautions will need to be taken to prevent the groundwater from freezing in the equipment. Because sampling during freezing temperatures may adversely impact the data quality objectives, the need for water sample collection during months when these conditions are likely to occur should be evaluated during site planning and special sampling measures may need to be developed. Ice formation in the flow-through-cell will cause the monitoring probes to act erratically. A transparent flow-through-cell needs to be used to observe if ice is forming in the cell. If ice starts to form on the other pieces of the sampling equipment, additional problems may occur.

## **HEALTH & SAFETY**

When working on-site, comply with all applicable OSHA requirements and the site's health/safety procedures. All proper personal protection clothing and equipment are to be worn. Some samples may contain biological and chemical hazards. These samples should be handled with suitable protection to skin, eyes, etc.

## **CAUTIONS**

The following cautions need to be considered when planning to collect groundwater samples when the below conditions occur.

If the groundwater degasses during purging of the monitoring well, dissolved gases and VOCs will be lost. When this happens, the groundwater data for dissolved gases (e.g., methane, ethene, ethane, dissolved oxygen, etc.) and VOCs will need to be qualified. Some conditions that can promote degassing are the use of a vacuum pump (e.g., peristaltic pumps), changes in aperture along the sampling tubing, and squeezing/pinching the pump's tubing which results in a pressure change.

When collecting the samples for dissolved gases and VOCs analyses, avoid aerating the groundwater in the pump's tubing. This can cause loss of the dissolved gases and VOCs in



the groundwater. Having the pump's tubing completely filled prior to sampling will avoid this problem when using a centrifugal pump or peristaltic pump.

Direct sun light and hot ambient air temperatures may cause the groundwater in the tubing and flow-through-cell to heat up. This may cause the groundwater to degas which will result in loss of VOCs and dissolved gases. When sampling under these conditions, the sampler will need to shade the equipment from the sunlight (e.g., umbrella, tent, etc.). If possible, sampling on hot days, or during the hottest time of the day, should be avoided. The tubing exiting the monitoring well should be kept as short as possible to avoid the sun light or ambient air from heating up the groundwater.

Thermal currents in the monitoring well may cause vertical mixing of water in the well bore. When the air temperature is colder than the groundwater temperature, it can cool the top of the water column. Colder water which is denser than warm water sinks to the bottom of the well and the warmer water at the bottom of the well rises, setting up a convection cell. "During low-flow sampling, the pumped water may be a mixture of convecting water from within the well casing and aquifer water moving inward through the screen. This mixing of water during low-flow sampling can substantially increase equilibration times, can cause false stabilization of indicator parameters, can give false indication of redox state, and can provide biological data that are not representative of the aquifer conditions" (Vrobesky 2007).

Failure to calibrate or perform proper maintenance on the sampling equipment and measurement instruments (e.g., dissolved oxygen meter, etc.) can result in faulty data being collected.

Interferences may result from using contaminated equipment, cleaning materials, sample containers, or uncontrolled ambient/surrounding air conditions (e.g., truck/vehicle exhaust nearby).

Cross contamination problems can be eliminated or minimized through the use of dedicated sampling equipment and/or proper planning to avoid ambient air interferences. Note that the use of dedicated sampling equipment can also significantly reduce the time needed to complete each sampling event, will promote consistency in the sampling, and may reduce sampling bias by having the pump's intake at a constant depth.

Clean and decontaminate all sampling equipment prior to use. All sampling equipment needs to be routinely checked to be free from contaminants and equipment blanks collected to ensure that the equipment is free of contaminants. Check the previous equipment blank data for the site (if they exist) to determine if the previous cleaning procedure removed the contaminants. If contaminants were detected and they are a concern, then a more vigorous cleaning procedure will be needed.

## **PERSONNEL QUALIFICATIONS**

All field samplers working at sites containing hazardous waste must meet the requirements of the OSHA regulations. OSHA regulations may require the sampler to take the 40 hour OSHA health and safety training course and a refresher course prior to engaging in any field activities, depending upon the site and field conditions.

The field samplers must be trained prior to the use of the sampling equipment, field instruments, and procedures. Training is to be conducted by an experienced sampler before initiating any sampling procedure.

The entire sampling team needs to read, and be familiar with, the site Health and Safety Plan, all relevant SOPs, and SAP/QAPP (and the most recent amendments) before going onsite for the sampling event. It is recommended that the field sampling leader attest to the understanding of these site documents and that it is recorded.

## **EQUIPMENT AND SUPPLIES**

### **A. Informational materials for sampling event**

A copy of the current Health and Safety Plan, SAP/QAPP, monitoring well construction data, location map(s), field data from last sampling event, manuals for sampling, and the monitoring instruments' operation, maintenance, and calibration manuals should be brought to the site.

### **B. Well keys.**

### **C. Extraction device**

Adjustable rate, submersible pumps (e.g., centrifugal, bladder, etc.) which are constructed of stainless steel or Teflon are preferred. Note: if extraction devices constructed of other materials are to be used, adequate information must be provided to show that the substituted materials do not leach contaminants nor cause interferences to the analytical procedures to be used. Acceptance of these materials must be obtained before the sampling event.

If bladder pumps are selected for the collection of VOCs and dissolved gases, the pump setting should be set so that one pulse will deliver a water volume that is sufficient to fill a 40 mL VOC vial. This is not mandatory, but is considered a "best practice". For the proper operation, the bladder pump will need a minimum amount of water above the pump; consult the manufacturer for the recommended submergence. The pump's recommended submergence value should be determined during the planning stage, since it may influence well construction and placement of dedicated pumps where water-level fluctuations are significant.

Adjustable rate, peristaltic pumps (suction) are to be used with caution when collecting samples for VOCs and dissolved gases (e.g., methane, carbon dioxide, etc.) analyses. Additional information on the use of peristaltic pumps can be found in Appendix A. If peristaltic pumps are used, the inside diameter of the rotor head tubing needs to match the inside diameter of the tubing installed in the monitoring well.

Inertial pumping devices (motor driven or manual) are not recommended. These devices frequently cause greater disturbance during purging and sampling, and are less easily controlled than submersible pumps (potentially increasing turbidity and sampling variability, etc.). This can lead to sampling results that are adversely affected by purging and sampling operations, and a higher degree of data variability.

#### **D. Tubing**

Teflon or Teflon-lined polyethylene tubing are preferred when sampling is to include VOCs, SVOCs, pesticides, PCBs and inorganics. Note: if tubing constructed of other materials is to be used, adequate information must be provided to show that the substituted materials do not leach contaminants nor cause interferences to the analytical procedures to be used. Acceptance of these materials must be obtained before the sampling event.

PVC, polypropylene or polyethylene tubing may be used when collecting samples for metal and other inorganics analyses.

The use of 1/4 inch or 3/8 inch (inside diameter) tubing is recommended. This will help ensure that the tubing remains liquid filled when operating at very low pumping rates when using centrifugal and peristaltic pumps.

Silastic tubing should be used for the section around the rotor head of a peristaltic pump. It should be less than a foot in length. The inside diameter of the tubing used at the pump rotor head must be the same as the inside diameter of tubing placed in the well. A tubing connector is used to connect the pump rotor head tubing to the well tubing. Alternatively, the two pieces of tubing can be connected to each other by placing the one end of the tubing inside the end of the other tubing. The tubing must not be reused.

#### **E. The water level measuring device**

Electronic "tape", pressure transducer, water level sounder/level indicator, etc. should be capable of measuring to 0.01 foot accuracy. Recording pressure transducers, mounted above the pump, are especially helpful in tracking water levels during pumping operations, but their use must include check measurements with a water level "tape" at the start and end of each sampling event.

#### **F. Flow measurement supplies**

Graduated cylinder (size according to flow rate) and stopwatch usually will suffice.

Large graduated bucket used to record total water purged from the well.

#### **G. Interface probe**

To be used to check on the presence of free phase liquids (LNAPL, or DNAPL) before purging begins (as needed).

#### **H. Power source (generator, nitrogen tank, battery, etc.)**

When a gasoline generator is used, locate it downwind and at least 30 feet from the well so that the exhaust fumes do not contaminate samples.

#### **I. Indicator field parameter monitoring instruments**

Use of a multi-parameter instrument capable of measuring pH, oxidation/reduction potential (ORP), dissolved oxygen (DO), specific conductance, temperature, and coupled with a flow-through-cell is required when measuring all indicator field parameters, except turbidity. Turbidity is collected using a separate instrument. Record equipment/instrument identification (manufacturer, and model number).

Transparent, small volume flow-through-cells (e.g., 250 mLs or less) are preferred. This allows observation of air bubbles and sediment buildup in the cell, which can interfere with the operation of the monitoring instrument probes, to be easily detected. A small volume cell facilitates rapid turnover of water in the cell between measurements of the indicator field parameters.

It is recommended to use a flow-through-cell and monitoring probes from the same manufacturer and model to avoid incompatibility between the probes and flow-through-cell.

Turbidity samples are collected before the flow-through-cell. A "T" connector coupled with a valve is connected between the pump's tubing and flow-through-cell. When a turbidity measurement is required, the valve is opened to allow the groundwater to flow into a container. The valve is closed and the container sample is then placed in the turbidimeter.

Standards are necessary to perform field calibration of instruments. A minimum of two standards are needed to bracket the instrument measurement range for all parameters except ORP which use a Zobell solution as a standard. For dissolved oxygen, a wet sponge used for the 100% saturation and a zero dissolved oxygen solution are used for the calibration.

Barometer (used in the calibration of the Dissolved Oxygen probe) and the conversion formula to convert the barometric pressure into the units of measure used by the Dissolved Oxygen meter are needed.

#### **J. Decontamination supplies**

Includes (for example) non-phosphate detergent, distilled/deionized water, isopropyl alcohol, etc.

#### **K. Record keeping supplies**

Logbook(s), well purging forms, chain-of-custody forms, field instrument calibration forms, etc.

#### **L. Sample bottles**

#### **M. Sample preservation supplies (as required by the analytical methods)**

#### **N. Sample tags or labels**

#### **O. PID or FID instrument**

If appropriate, to detect VOCs for health and safety purposes, and provide qualitative field evaluations.

## **P. Miscellaneous Equipment**

Equipment to keep the sampling apparatus shaded in the summer (e.g., umbrella) and from freezing in the winter. If the pump's tubing is allowed to heat up in the warm weather, the cold groundwater may degas as it is warmed in the tubing.

## **EQUIPMENT/INSTRUMENT CALIBRATION**

Prior to the sampling event, perform maintenance checks on the equipment and instruments according to the manufacturer's manual and/or applicable SOP. This will ensure that the equipment/instruments are working properly before they are used in the field.

Prior to sampling, the monitoring instruments must be calibrated and the calibration documented. The instruments are calibrated using U.S Environmental Protection Agency Region 1 *Calibration of Field Instruments (temperature, pH, dissolved oxygen, conductivity/specific conductance, oxidation/reduction [ORP], and turbidity)*, January 19, 2010, or latest version or from one of the methods listed in 40CFR136, 40CFR141 and SW-846.

The instruments shall be calibrated at the beginning of each day. If the field measurement falls outside the calibration range, the instrument must be re-calibrated so that all measurements fall within the calibration range. At the end of each day, a calibration check is performed to verify that instruments remained in calibration throughout the day. This check is performed while the instrument is in measurement mode, not calibration mode. If the field instruments are being used to monitor the natural attenuation parameters, then a calibration check at mid-day is highly recommended to ensure that the instruments did not drift out of calibration. Note: during the day if the instrument reads zero or a negative number for dissolved oxygen, pH, specific conductance, or turbidity (negative value only), this indicates that the instrument drifted out of calibration or the instrument is malfunctioning. If this situation occurs the data from this instrument will need to be qualified or rejected.

## **PRELIMINARY SITE ACTIVITIES (as applicable)**

Check the well for security (damage, evidence of tampering, missing lock, etc.) and record pertinent observations (include photograph as warranted).

If needed lay out sheet of clean polyethylene for monitoring and sampling equipment, unless equipment is elevated above the ground (e.g., on a table, etc.).

Remove well cap and if appropriate measure VOCs at the rim of the well with a PID or FID instrument and record reading in field logbook or on the well purge form.

If the well casing does not have an established reference point (usually a V-cut or indelible mark in the well casing), make one. Describe its location and record the date of the mark in the logbook (consider a photographic record as well). All water level measurements must be recorded relative to this reference point (and the altitude of this point should be determined using techniques that are appropriate to site's DQOs).

If water-table or potentiometric surface map(s) are to be constructed for the sampling event, perform synoptic water level measurement round (in the shortest possible time) before any purging and sampling activities begin. If possible, measure water level depth (to 0.01 ft.) and total well depth (to 0.1 ft.) the day before sampling begins, in order to allow for re-settlement of any particulates in the water column. This is especially important for those wells that have not been recently sampled because sediment buildup in the well may require the well to be redeveloped. If measurement of total well depth is not made the day before, it should be measured after sampling of the well is complete. All measurements must be taken from the established referenced point. Care should be taken to minimize water column disturbance.

Check newly constructed wells for the presence of LNAPLs or DNAPLs before the initial sampling round. If none are encountered, subsequent check measurements with an interface probe may not be necessary unless analytical data or field analysis signal a worsening situation. This SOP cannot be used in the presence of LNAPLs or DNAPLs. If NAPLs are present, the project team must decide upon an alternate sampling method. All project modifications must be approved and documented prior to implementation.

If available check intake depth and drawdown information from previous sampling event(s) for each well. Duplicate, to the extent practicable, the intake depth and extraction rate (use final pump dial setting information) from previous event(s). If changes are made in the intake depth or extraction rate(s) used during previous sampling event(s), for either portable or dedicated extraction devices, record new values, and explain reasons for the changes in the field logbook.

## **PURGING AND SAMPLING PROCEDURE**

Purging and sampling wells in order of increasing chemical concentrations (known or anticipated) are preferred.

The use of dedicated pumps is recommended to minimize artificial mobilization and entrainment of particulates each time the well is sampled. Note that the use of dedicated sampling equipment can also significantly reduce the time needed to complete each

sampling event, will promote consistency in the sampling, and may reduce sampling bias by having the pump's intake at a constant depth.

#### **A. Initial Water Level**

Measure the water level in the well before installing the pump if a non-dedicated pump is being used. The initial water level is recorded on the purge form or in the field logbook.

#### **B. Install Pump**

Lower pump, safety cable, tubing and electrical lines slowly (to minimize disturbance) into the well to the appropriate depth (may not be the mid-point of the screen/open interval). The Sampling and Analysis Plan/Quality Assurance Project Plan should specify the sampling depth (used previously), or provide criteria for selection of intake depth for each new well. If possible keep the pump intake at least two feet above the bottom of the well, to minimize mobilization of particulates present in the bottom of the well.

Pump tubing lengths, above the top of well casing should be kept as short as possible to minimize heating the groundwater in the tubing by exposure to sun light and ambient air temperatures. Heating may cause the groundwater to degas, which is unacceptable for the collection of samples for VOC and dissolved gases analyses.

#### **C. Measure Water Level**

Before starting pump, measure water level. Install recording pressure transducer, if used to track drawdowns, to initialize starting condition.

#### **D. Purge Well**

From the time the pump starts purging and until the time the samples are collected, the purged water is discharged into a graduated bucket to determine the total volume of groundwater purged. This information is recorded on the purge form or in the field logbook.

Start the pump at low speed and slowly increase the speed until discharge occurs. Check water level. Check equipment for water leaks and if present fix or replace the affected equipment. Try to match pumping rate used during previous sampling event(s). Otherwise, adjust pump speed until there is little or no water level drawdown. If the minimal drawdown that can be achieved exceeds 0.3 feet, but remains stable, continue purging.



Monitor and record the water level and pumping rate every five minutes (or as appropriate) during purging. Record any pumping rate adjustments (both time and flow rate). Pumping rates should, as needed, be reduced to the minimum capabilities of the pump to ensure stabilization of the water level. Adjustments are best made in the first fifteen minutes of pumping in order to help minimize purging time. During pump start-up, drawdown may exceed the 0.3 feet target and then "recover" somewhat as pump flow adjustments are made. Purge volume calculations should utilize stabilized drawdown value, not the initial drawdown. If the initial water level is above the top of the screen do not allow the water level to fall into the well screen. The final purge volume must be greater than the stabilized drawdown volume plus the pump's tubing volume. If the drawdown has exceeded 0.3 feet and stabilizes, calculate the volume of water between the initial water level and the stabilized water level. Add the volume of the water which occupies the pump's tubing to this calculation. This combined volume of water needs to be purged from the well after the water level has stabilized before samples are collected.

Avoid the use of constriction devices on the tubing to decrease the flow rate because the constrictor will cause a pressure difference in the water column. This will cause the groundwater to degas and result in a loss of VOCs and dissolved gasses in the groundwater samples.

Note: the flow rate used to achieve a stable pumping level should remain constant while monitoring the indicator parameters for stabilization and while collecting the samples.

Wells with low recharge rates may require the use of special pumps capable of attaining very low pumping rates (e.g., bladder, peristaltic), and/or the use of dedicated equipment. For new monitoring wells, or wells where the following situation has not occurred before, if the recovery rate to the well is less than 50 mL/min., or the well is being essentially dewatered during purging, the well should be sampled as soon as the water level has recovered sufficiently to collect the volume needed for all anticipated samples. The project manager or field team leader will need to make the decision when samples should be collected, how the sample is to be collected, and the reasons recorded on the purge form or in the field logbook. A water level measurement needs to be performed and recorded before samples are collected. If the project manager decides to collect the samples using the pump, it is best during this recovery period that the pump intake tubing not be removed, since this will aggravate any turbidity problems. Samples in this specific situation may be collected without stabilization of indicator field parameters. Note that field conditions and efforts to overcome problematic situations must be recorded in order to support field decisions to deviate from normal procedures described in this SOP. If this type of problematic situation persists in a well, then water sample collection should be changed to a passive or no-purge method, if consistent with the site's DQOs, or have a new well installed.

## **E. Monitor Indicator Field Parameters**

After the water level has stabilized, connect the "T" connector with a valve and the flow-through-cell to monitor the indicator field parameters. If excessive turbidity is anticipated or encountered with the pump startup, the well may be purged for a while without connecting up the flow-through-cell, in order to minimize particulate buildup in the cell (This is a judgment call made by the sampler). Water level drawdown measurements should be made as usual. If possible, the pump may be installed the day before purging to allow particulates that were disturbed during pump insertion to settle.

During well purging, monitor indicator field parameters (turbidity, temperature, specific conductance, pH, ORP, DO) at a frequency of five minute intervals or greater. The pump's flow rate must be able to "turn over" at least one flow-through-cell volume between measurements (for a 250 mL flow-through-cell with a flow rate of 50 mLs/min., the monitoring frequency would be every five minutes; for a 500 mL flow-through-cell it would be every ten minutes). If the cell volume cannot be replaced in the five minute interval, then the time between measurements must be increased accordingly. Note: during the early phase of purging emphasis should be put on minimizing and stabilizing pumping stress, and recording those adjustments followed by stabilization of indicator parameters. Purging is considered complete and sampling may begin when all the above indicator field parameters have stabilized. Stabilization is considered to be achieved when three consecutive readings are within the following limits:

**Turbidity** (10% for values greater than 5 NTU; if three Turbidity values are less than 5 NTU, consider the values as stabilized),

**Dissolved Oxygen** (10% for values greater than 0.5 mg/L, if three Dissolved Oxygen values are less than 0.5 mg/L, consider the values as stabilized),

**Specific Conductance** (3%),

**Temperature** (3%),

**pH** ( $\pm 0.1$  unit),

**Oxidation/Reduction Potential** ( $\pm 10$  millivolts).

All measurements, except turbidity, must be obtained using a flow-through-cell. Samples for turbidity measurements are obtained before water enters the flow-through-cell. Transparent flow-through-cells are preferred, because they allow field personnel to watch for particulate build-up within the cell. This build-up may affect indicator field parameter values measured within the cell. If the cell needs to be cleaned during purging operations, continue pumping and disconnect cell for cleaning, then reconnect after cleaning and continue monitoring activities. Record start and stop times and give a brief description of cleaning activities.

The flow-through-cell must be designed in a way that prevents gas bubble entrapment in the cell. Placing the flow-through-cell at a 45 degree angle with the port facing upward can help remove bubbles from the flow-through-cell (see Appendix B Low-Flow Setup Diagram). All during the measurement process, the flow-through-cell must remain free of any gas bubbles. Otherwise, the monitoring probes may act erratically. When the pump is turned off or cycling on/off (when using a bladder pump), water in the cell must not drain out. Monitoring probes must remain submerged in water at all times.

#### **F. Collect Water Samples**

When samples are collected for laboratory analyses, the pump's tubing is disconnected from the "T" connector with a valve and the flow-through-cell. The samples are collected directly from the pump's tubing. Samples must not be collected from the flow-through-cell or from the "T" connector with a valve.

VOC samples are normally collected first and directly into pre-preserved sample containers. However, this may not be the case for all sampling locations; the SAP/QAPP should list the order in which the samples are to be collected based on the project's objective(s). Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

If the pump's flow rate is too high to collect the VOC/dissolved gases samples, collect the other samples first. Lower the pump's flow rate to a reasonable rate and collect the VOC/dissolved gases samples and record the new flow rate.

During purging and sampling, the centrifugal/peristaltic pump tubing must remain filled with water to avoid aeration of the groundwater. It is recommended that 1/4 inch or 3/8 inch (inside diameter) tubing be used to help insure that the sample tubing remains water filled. If the pump tubing is not completely filled to the sampling point, use the following procedure to collect samples: collect non-VOC/dissolved gases samples first, then increase flow rate slightly until the water completely fills the tubing, collect the VOC/dissolved gases samples, and record new drawdown depth and flow rate.

For bladder pumps that will be used to collect VOC or dissolved gas samples, it is recommended that the pump be set to deliver long pulses of water so that one pulse will fill a 40 mL VOC vial.

Use pre-preserved sample containers or add preservative, as required by analytical methods, to the samples immediately after they are collected. Check the analytical methods (e.g. EPA SW-846, 40 CFR 136, water supply, etc.) for additional information on preservation.

If determination of filtered metal concentrations is a sampling objective, collect filtered water samples using the same low flow procedures. The use of an in-line filter (transparent housing preferred) is required, and the filter size ( $0.45\ \mu\text{m}$  is commonly used) should be based on the sampling objective. Pre-rinse the filter with groundwater prior to sample collection. Make sure the filter is free of air bubbles before samples are collected. Preserve the filtered water sample immediately. Note: filtered water samples are not an acceptable substitute for unfiltered samples when the monitoring objective is to obtain chemical concentrations of total mobile contaminants in groundwater for human health or ecological risk calculations.

Label each sample as collected. Samples requiring cooling will be placed into a cooler with ice or refrigerant for delivery to the laboratory. Metal samples after acidification to a pH less than 2 do not need to be cooled.

### **G. Post Sampling Activities**

If a recording pressure transducer is used to track drawdown, re-measure water level with tape.

After collection of samples, the pump tubing may be dedicated to the well for re-sampling (by hanging the tubing inside the well), decontaminated, or properly discarded.

Before securing the well, measure and record the well depth (to 0.1 ft.), if not measured the day before purging began. Note: measurement of total well depth annually is usually sufficient after the initial low stress sampling event. However, a greater frequency may be needed if the well has a "silting" problem or if confirmation of well identity is needed.

Secure the well.

### **DECONTAMINATION**

Decontaminate sampling equipment prior to use in the first well and then following sampling of each well. Pumps should not be removed between purging and sampling operations. The pump, tubing, support cable and electrical wires which were in contact with the well should be decontaminated by one of the procedures listed below.

The use of dedicated pumps and tubing will reduce the amount of time spent on decontamination of the equipment. If dedicated pumps and tubing are used, only the initial sampling event will require decontamination of the pump and tubing.

Note if the previous equipment blank data showed that contaminant(s) were present after using the below procedure or the one described in the SAP/QAPP, a more vigorous procedure may be needed.

#### Procedure 1

Decontaminating solutions can be pumped from either buckets or short PVC casing sections through the pump and tubing. The pump may be disassembled and flushed with the decontaminating solutions. It is recommended that detergent and alcohol be used sparingly in the decontamination process and water flushing steps be extended to ensure that any sediment trapped in the pump is removed. The pump exterior and electrical wires must be rinsed with the decontaminating solutions, as well. The procedure is as follows:

Flush the equipment/pump with potable water.

Flush with non-phosphate detergent solution. If the solution is recycled, the solution must be changed periodically.

Flush with potable or distilled/deionized water to remove all of the detergent solution. If the water is recycled, the water must be changed periodically.

Optional - flush with isopropyl alcohol (pesticide grade; must be free of ketones {e.g., acetone}) or with methanol. This step may be required if the well is highly contaminated or if the equipment blank data from the previous sampling event show that the level of contaminants is significant.

Flush with distilled/deionized water. This step must remove all traces of alcohol (if used) from the equipment. The final water rinse must not be recycled.

#### Procedure 2

Steam clean the outside of the submersible pump.

Pump hot potable water from the steam cleaner through the inside of the pump. This can be accomplished by placing the pump inside a three or four inch diameter PVC pipe with end cap. Hot water from the steam cleaner jet will be directed inside the PVC pipe and the pump exterior will be cleaned. The hot water from the steam cleaner will then be pumped from the PVC pipe through the pump and collected into another container. Note: additives or solutions should not be added to the steam cleaner.

Pump non-phosphate detergent solution through the inside of the pump. If the solution is recycled, the solution must be changed periodically.

Pump potable water through the inside of the pump to remove all of the detergent solution. If the solution is recycled, the solution must be changed periodically.

Pump distilled/deionized water through the pump. The final water rinse must not be recycled.

## **FIELD QUALITY CONTROL**

Quality control samples are required to verify that the sample collection and handling process has not compromised the quality of the groundwater samples. All field quality control samples must be prepared the same as regular investigation samples with regard to sample volume, containers, and preservation. Quality control samples include field duplicates, equipment blanks, matrix spike/matrix spike duplicates, trip blanks (VOCs), and temperature blanks.

## **FIELD LOGBOOK**

A field log shall be kept to document all groundwater field monitoring activities (see Appendix C, example table), and record the following for each well:

Site name, municipality, state.

Well identifier, latitude-longitude or state grid coordinates.

Measuring point description (e.g., north side of PVC pipe).

Well depth, and measurement technique.

Well screen length.

Pump depth.

Static water level depth, date, time and measurement technique.

Presence and thickness of immiscible liquid (NAPL) layers and detection method.

Pumping rate, drawdown, indicator parameters values, calculated or measured total volume pumped, and clock time of each set of measurements.

Type of tubing used and its length.

Type of pump used.

Clock time of start and end of purging and sampling activity.

Types of sample bottles used and sample identification numbers.

Preservatives used.

Parameters requested for analyses.

Field observations during sampling event.

Name of sample collector(s).

Weather conditions, including approximate ambient air temperature.

QA/QC data for field instruments.

Any problems encountered should be highlighted.

Description of all sampling/monitoring equipment used, including trade names, model number, instrument identification number, diameters, material composition, etc.

## **DATA REPORT**

Data reports are to include laboratory analytical results, QA/QC information, field indicator parameters measured during purging, field instrument calibration information, and whatever other field logbook information is needed to allow for a full evaluation of data usability.

Note: the use of trade, product, or firm names in this sampling procedure is for descriptive purposes only and does not constitute endorsement by the U.S. EPA.

## **REFERENCES**

Cohen, R.M. and J.W. Mercer, 1993, *DNAPL Site Evaluation*; C.K. Smoley (CRC Press), Boca Raton, Florida.

Robert W. Puls and Michael J. Barcelona, *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures*, April 1996 (EPA/540/S-95/504).

U.S. Environmental Protection Agency, 1992, *RCRA Ground-Water Monitoring: Draft Technical Guidance*; Washington, DC (EPA/530-R-93-001).

U.S. Environmental Protection Agency, 1987, *A Compendium of Superfund Field Operations Methods*; Washington, DC (EPA/540/P-87/001).

U.S. Environmental Protection Agency, Region 1, *Calibration of Field Instruments (temperature, pH, dissolved oxygen, conductivity/specific conductance, oxidation/reduction [ORP], and turbidity)*, January 19, 2010 or latest version.

U.S. Environmental Protection Agency, EPA SW-846.

U.S. Environmental Protection Agency, 40 CFR 136.

U.S. Environmental Protection Agency, 40 CFR 141.

Vroblesky, Don A., Clifton C. Casey, and Mark A. Lowery, Summer 2007, Influence of Dissolved Oxygen Convection on Well Sampling, *Ground Water Monitoring & Remediation* 27, no. 3: 49-58.



## APPENDIX A PERISTALTIC PUMPS

Before selecting a peristaltic pump to collect groundwater samples for VOCs and/or dissolved gases (e.g., methane, carbon dioxide, etc.) consideration should be given to the following:

- The decision of whether or not to use a peristaltic pump is dependent on the intended use of the data.
- If the additional sampling error that may be introduced by this device is NOT of concern for the VOC/dissolved gases data's intended use, then this device may be acceptable.
- If minor differences in the groundwater concentrations could effect the decision, such as to continue or terminate groundwater cleanup or whether the cleanup goals have been reached, then this device should NOT be used for VOC/dissolved gases sampling. In these cases, centrifugal or bladder pumps are a better choice for more accurate results.

EPA and USGS have documented their concerns with the use of the peristaltic pumps to collect water sample in the below documents.

- "Suction Pumps are not recommended because they may cause degassing, pH modification, and loss of volatile compounds" *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001, December 1987.
- "The agency does not recommend the use of peristaltic pumps to sample ground water particularly for volatile organic analytes" *RCRA Ground-Water Monitoring Draft Technical Guidance*, EPA Office of Solid Waste, November 1992.
- "The peristaltic pump is limited to shallow applications and can cause degassing resulting in alteration of pH, alkalinity, and volatiles loss", *Low-flow (Minimal drawdown) Ground-Water Sampling Procedures*, by Robert Puls & Michael Barcelona, April 1996, EPA/540/S-95/504.
- "Suction-lift pumps, such as peristaltic pumps, can operate at a very low pumping rate; however, using negative pressure to lift the sample can result in the loss of volatile analytes", USGS Book 9 Techniques of Water-Resources Investigation, Chapter A4. (Version 2.0, 9/2006).

## APPENDIX B

### SUMMARY OF SAMPLING INSTRUCTIONS

These instructions are for using an adjustable rate, submersible pump or a peristaltic pump with the pump's intake placed at the midpoint of a 10 foot or less well screen or an open interval. The water level in the monitoring well is above the top of the well screen or open interval, the ambient temperature is above 32°F, and the equipment is not dedicated. Field instruments are already calibrated. The equipment is setup according to the diagram at the end of these instructions.

1. Review well installation information. Record well depth, length of screen or open interval, and depth to top of the well screen. Determine the pump's intake depth (e.g., mid-point of screen/open interval).
2. On the day of sampling, check security of the well casing, perform any safety checks needed for the site, lay out a sheet of polyethylene around the well (if necessary), and setup the equipment. If necessary a canopy or an equivalent item can be setup to shade the pump's tubing and flow-through-cell from the sun light to prevent the sun light from heating the groundwater.
3. Check well casing for a reference mark. If missing, make a reference mark. Measure the water level (initial) to 0.01 ft. and record this information.
4. Install the pump's intake to the appropriate depth (e.g., midpoint) of the well screen or open interval. Do not turn-on the pump at this time.
5. Measure water level and record this information.
6. Turn-on the pump and discharge the groundwater into a graduated waste bucket. Slowly increase the flow rate until the water level starts to drop. Reduce the flow rate slightly so the water level stabilizes. Record the pump's settings. Calculate the flow rate using a graduated container and a stop watch. Record the flow rate. Do not let the water level drop below the top of the well screen.

If the groundwater is highly turbid or colored, continue to discharge the water into the bucket until the water clears (visual observation); this usually takes a few minutes. The turbid or colored water is usually from the well being disturbed during the pump installation. If the water does not clear, then you need to make a choice whether to continue purging the well (hoping that it will clear after a reasonable time) or continue to

the next step. Note, it is sometimes helpful to install the pump the day before the sampling event so that the disturbed materials in the well can settle out.

If the water level drops to the top of the well screen during the purging of the well, stop purging the well, and do the following:

Wait for the well to recharge to a sufficient volume so samples can be collected. This may take awhile (pump maybe removed from well, if turbidity is not a problem). The project manager will need to make the decision when samples should be collected and the reasons recorded in the site's log book. A water level measurement needs to be performed and recorded before samples are collected. When samples are being collected, the water level must not drop below the top of the screen or open interval. Collect the samples from the pump's tubing. Always collect the VOCs and dissolved gases samples first. Normally, the samples requiring a small volume are collected before the large volume samples are collected just in case there is not sufficient water in the well to fill all the sample containers. All samples must be collected, preserved, and stored according to the analytical method. Remove the pump from the well and decontaminate the sampling equipment.

If the water level has dropped 0.3 feet or less from the initial water level (water level measure before the pump was installed); proceed to Step 7. If the water level has dropped more than 0.3 feet, calculate the volume of water between the initial water level and the stabilized water level. Add the volume of the water which occupies the pump's tubing to this calculation. This combined volume of water needs to be purged from the well after the water level has stabilized before samples are be collected.

7. Attach the pump's tubing to the "T" connector with a valve (or a three-way stop cock). The pump's tubing from the well casing to the "T" connector must be as short as possible to prevent the groundwater in the tubing from heating up from the sun light or from the ambient air. Attach a short piece of tubing to the other end of the end of the "T" connector to serve as a sampling port for the turbidity samples. Attach the remaining end of the "T" connector to a short piece of tubing and connect the tubing to the flow-through-cell bottom port. To the top port, attach a small piece of tubing to direct the water into a calibrated waste bucket. Fill the cell with the groundwater and remove all gas bubbles from the cell. Position the flow-through-cell in such a way that if gas bubbles enter the cell they can easily exit the cell. If the ports are on the same side of the cell and the cell is cylindrical shape, the cell can be placed at a 45-degree angle with the ports facing upwards; this position should keep any gas bubbles entering the cell away from the monitoring probes and allow the gas bubbles to exit the cell easily (see Low-Flow Setup Diagram). Note,

make sure there are no gas bubbles caught in the probes' protective guard; you may need to shake the cell to remove these bubbles.

8. Turn-on the monitoring probes and turbidity meter.

9. Record the temperature, pH, dissolved oxygen, specific conductance, and oxidation/reduction potential measurements. Open the valve on the "T" connector to collect a sample for the turbidity measurement, close the valve, do the measurement, and record this measurement. Calculate the pump's flow rate from the water exiting the flow-through-cell using a graduated container and a stop watch, and record the measurement. Measure and record the water level. Check flow-through-cell for gas bubbles and sediment; if present, remove them.

10. Repeat Step 9 every 5 minutes or as appropriate until monitoring parameters stabilized. Note at least one flow-through-cell volume must be exchanged between readings. If not, the time interval between readings will need to be increased. Stabilization is achieved when three consecutive measurements are within the following limits:

**Turbidity** (10% for values greater than 5 NTUs; if three Turbidity values are less than 5 NTUs, consider the values as stabilized),

**Dissolved Oxygen** (10% for values greater than 0.5 mg/L, if three Dissolved Oxygen values are less than 0.5 mg/L, consider the values as stabilized),

**Specific Conductance** (3%),

**Temperature** (3%),

**pH** ( $\pm 0.1$  unit),

**Oxidation/Reduction Potential** ( $\pm 10$  millivolts).

If these stabilization requirements do not stabilize in a reasonable time, the probes may have been coated from the materials in the groundwater, from a buildup of sediment in the flow-through-cell, or a gas bubble is lodged in the probe. The cell and the probes will need to be cleaned. Turn-off the probes (not the pump), disconnect the cell from the "T" connector and continue to purge the well. Disassemble the cell, remove the sediment, and clean the probes according to the manufacturer's instructions. Reassemble the cell and connect the cell to the "T" connector. Remove all gas bubbles from the cell, turn-on the probes, and continue the measurements. Record that the time the cell was cleaned.

11. When it is time to collect the groundwater samples, turn-off the monitoring probes, and disconnect the pump's tubing from the "T" connector. If you are using a centrifugal or peristaltic pump check the pump's tubing to determine if the tubing is completely filled with water (no air space).

All samples must be collected and preserved according to the analytical method. VOCs and dissolved gases samples are normally collected first and directly into pre-preserved sample containers. However, this may not be the case for all sampling locations; the SAP/QAPP should list the order in which the samples are to be collected based on the project's objective(s). Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

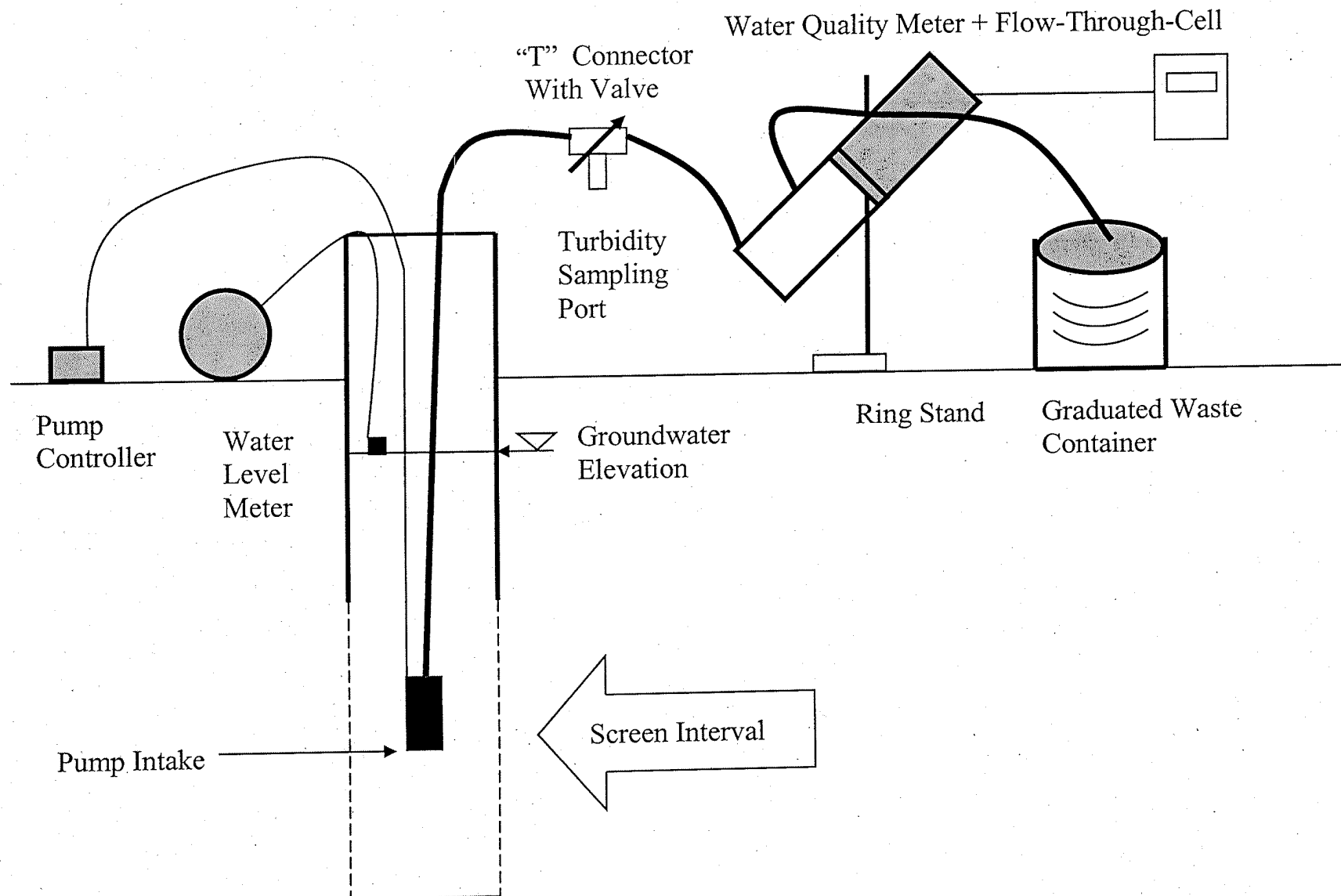
If the pump's tubing is not completely filled with water and the samples are being collected for VOCs and/or dissolved gases analyses using a centrifugal or peristaltic pump, do the following:

All samples must be collected and preserved according to the analytical method. The VOCs and the dissolved gases (e.g., methane, ethane, ethene, and carbon dioxide) samples are collected last. When it becomes time to collect these samples increase the pump's flow rate until the tubing is completely filled. Collect the samples and record the new flow rate.

12. Store the samples according to the analytical method.

13. Record the total purged volume (graduated waste bucket). Remove the pump from the well and decontaminate the sampling equipment.

Low-Flow Setup Diagram



APPENDIX C  
EXAMPLE (Minimum Requirements)  
WELL PURGING-FIELD WATER QUALITY MEASUREMENTS FORM

[illegible]

1. Pump dial setting (for example: hertz, cycles/min, etc).
2.  $\mu$ Siemens per cm (same as  $\mu$ mhos/cm) at 25°C.
3. Oxidation reduction potential (ORP)

## STANDARD OPERATING PROCEDURE

### SOP-13

## GLOBAL POSITIONING SYSTEM

### 1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide the field personnel with basic instructions for operating a handheld Global Positioning System (GPS) unit allowing field personnel to set GPS parameters in the receiver, record GPS positions on the field device, and update existing Geographic Information System (GIS) data. **This SOP is specific to GIS quality data collection for Trimble®-specific hardware and software.**

If possible, the Trimble® GeoXM™ or GeoXH™ operators manual should be downloaded onto the operator's personal computer for reference before or while in the field. The manual can be downloaded at <http://trl.trimble.com/docushare/dsweb/Get/Document-311749/TerraSyncReferenceManual.pdf>

Unless the operator is proficient in the setup and operation of the GPS unit, the Project Manager (or designee) should have the GPS unit shipped to the project-specific contact listed below in the Pittsburgh, Pennsylvania, office at least five working days prior to field mobilization so project-specific shape files, data points, background images, and correct coordinate systems can be uploaded into the unit.

Tetra Tech NUS, Inc.  
Attn: Kevin Moore  
661 Anderson Drive, Bldg #7  
Pittsburgh, PA 15220

### 2.0 EQUIPMENT

The following hardware and software should be utilized for locating and establishing GPS points in the field:



## **2.1 GPS Hardware**

- Hand-held GPS unit capable of sub-meter accuracy (i.e. Trimble® GeoXM™ or Trimble® GeoXH™). This includes the docking cradle, A/C adapter, stylus, and USB cable for data transfer.

### Optional Accessories:

- External antenna
- Range pole
- Hardware clamp (for mounting GPS unit to range pole)
- GeoBeacon
- Writing utensil (preferably black pen with indelible ink)
- Non-metallic pin flags for temporary marking of positions
- personal computer

## **2.2 GPS Software**

The following software is required to transfer data from the handheld GPS unit to a personal computer:

- Trimble® TerraSync version 2.6 or later (pre-loaded onto GPS unit from vendor)
- Microsoft® ActiveSync® version 4.5 or later. Download to personal computer from:  
<http://www.microsoft.com/windowsmobile/en-us/downloads/microsoft/activesync-download.mspx>
- Trimble® Data Transfer Utility (freeware version 2.1 or later). Download to personal computer from:  
<http://www.trimble.com/datatransfer.shtml>

## **3.0 START-UP PROCEDURES**

Prior to using the GPS in the field, ensure the unit is fully charged. The unit may come charged from the vendor, but an overnight charge is recommended prior to fieldwork.

The Geo-series GPS units require a docking cradle for both charging and data transfer. The Geo-series GPS unit is docked in the cradle by first inserting the domed end in the top of the cradle, then gently seating the contact end into the latch. The power charger is then connected to the cradle at the back end using the twist-lock connector. Attach a USB cable as needed between the cradle (B end) and the laptop/PC (A end).

It is recommended that the user also be familiar and check various Windows Mobile settings. One critical setting is the Power Options. The backlight should be set as needed to conserve power when not in use.

#### Start Up:

- 1) Power on the GPS unit by pushing the small green button located on the lower right front of the unit.
- 2) Using the stylus that came with the GPS unit, launch **TerraSync** from the Windows Operating System by tapping on the start icon located in the upper left hand corner of the screen and then tap on **TerraSync** from the drop-down list.
- 3) If the unit does not default to the Setup screen, tap the Main Menu (uppermost left tab, just below the Windows icon) and select Setup.
- 4) If the unit was previously shipped to the Pittsburgh office for setup, you can skip directly to Section 4.0. However, to confirm or change settings, continue on to Section 3.1.

### **3.1      Confirm Setup Settings**

Use the Setup section to confirm the TerraSync software settings. To open the Setup section, tap the Main Menu and select Setup.

- 1) Coordinate System
  - a. Tap on the Coordinate System.
  - b. Verify the project specs are correct for your specific project by scrolling through the various settings. Edit as needed and then tap OK; otherwise, tap Cancel to return to Setup Menu.  
**Note:** It is always best to utilize the Cancel tab rather than the OK tab if no changes are made since configurations are easily changed by mistake.
  - c. Tap on the Units.
  - d. Verify the user preferences are correct for your specific project by scrolling through the various settings. Edit as needed and then tap OK; otherwise, tap Cancel to return to Setup Menu.
  - e. Tap Real-time Settings.

- f. Verify the Real-time Settings are correct for your specific project by scrolling through the various settings. Edit as needed and then tap OK; otherwise, tap Cancel to return to Setup Menu.
- g. The GPS unit is now configured correctly for your specific project.

#### 4.0 ANTENNA CONNECTION

- 1) If a connection has been properly made with the internal antenna, a satellite icon along with the number of usable satellites will appear at the top of the screen next to the battery icon. If no connection is made (e.g.: no satellite icon), tap on the GPS tab to connect antenna.
- 2) At this point the GPS unit is ready to begin collecting data.

#### 5.0 COLLECTING NEW DATA IN THE FIELD

- 1) From the Main Menu select Data.
- 2) From the Sub Menu (located below the Data tab) select New which will bring up the New Data File menu.
- 3) An auto-generated filename appears and should be edited for your specific project. If the integral keyboard does not appear, tap the small keyboard icon at the bottom of the screen.
- 4) After entering the file name, tap Create to create the new file.
- 5) Confirm antenna height if screen appears. Antenna height is the height that the GPS unit will be held from the ground surface (Typically 3 to 4 feet).
- 6) The Choose Feature screen appears.

##### 5.1 Collecting Features

- 1) If not already open, the Collect Feature screen can be opened by tapping the Main Menu and selecting Data. The Sub Menu should default to Collect.
- 2) **Do not begin the data logging process until you are at the specific location for which you intend to log the data.**
- 3) A known reference or two should be shot at the beginning and at the end of each day in which the GPS unit is being used. This allows for greater accuracy during post-processing of the data.
- 4) Upon arriving at the specific location, tap on Point\_generic as the Feature Name.
- 5) Tap Create to begin data logging.
- 6) In the Comment Box enter sample ID or location-specific information.

- 7) Data logging can be confirmed by viewing the writing pencil icon in the upper part of the screen. Also, the logging counter will begin. As a Rule of Thumb, accumulate a minimum of 20 readings on the counter, per point, as indicated by the logging counter before saving the GPS data.
- 8) Once the counter has reached a minimum number of counts (i.e. 20), tap on OK to save the data point to the GPS unit. Confirm the feature. All data points are automatically saved within the GPS unit.
- 9) Repeat steps 2 through 8, giving each data point a unique name or number.

**Note:** If the small satellite icon or the pencil icon is blinking, this is an indication the GPS unit is not collecting data. A possible problem may be too few satellites. While still in data collection mode, tap on Main Menu in upper left hand corner of the screen and select Status. Skyplot will display as the default showing the number of available satellites. To increase productivity (number of usable satellites) use the stylus to move the pointer on the productivity and precision line to the left. This will decrease precision, but increase productivity. The precision and productivity of the GPS unit can be adjusted as the number of usable satellites changes throughout the day. To determine if GPS is correctly recording data, see Section 5.2.

## **5.2      Viewing Data or Entering Additional Data Points to the Current File**

- 1) To view the stored data points in the current file, tap on the Main Menu and select Map. Stored data points for that particular file will appear. Use the +/- and <-/-> icons in lower left hand corner of screen to zoom in/out and to manipulate current view.
- 2) To return to data collection, tap on the Main Menu and select Data. You are now ready to continue to collect additional data points.

## **5.3      Viewing Data or Entering Data Points from an Existing File**

- 1) To view data points from a previous file, tap on Main Menu and select Data, then select File Manager from the Sub Menu.
- 4) Highlight the file you want to view and select Map from the Main Menu.
- 5) To add data points to this file, tap on Main Menu and select Data. Continue to collect additional data points.

## **6.0      NAVIGATION**

This section provides instructions on navigating to saved data points in an existing file within the GPS unit.

- 1) From the Main Menu select Map.
- 2) Using the Select tool, pick the point on the map to where you want to navigate.
- 3) The location you select will have a box placed around the point.
- 4) From the Options menu, choose the Set Nav Target (aka set navigation target).
- 5) The location will now have double blue flags indicating this point is your navigation target.
- 6) From the Main Menu select Navigation.
- 7) The dial and data on this page will indicate what distance and direction you need to travel to reach the desired target.
- 8) Follow the navigation guide until you reach the point you select.
- 9) Repeat as needed for any map point by going back to Step 1.

## **7.0 PULLING IN A BACKGROUND FILE**

This section provides instructions on pulling in a pre-loaded background file. These files are helpful in visualizing your current location.

- 1) From the Main Menu select Map, then tap on Layers, then select the background file from drop down list.
- 2) Select the project-specific background file from the list of available files.
- 3) Once the selected background file appears, the operator can manipulate the screen using the +/- and <-/-> functions at the bottom of the screen.
- 4) In operating mode, the operator's location will show up on the background file as a floating "x".

## **8.0 DATA TRANSFER**

This section provides instructions on how to transfer stored data on the handheld GPS unit to a personal computer. Prior to transferring data from the GPS unit to a computer, Microsoft ActiveSync and Trimble Data Transfer Utility software must be downloaded to the computer from the links provided in Section 2.2 (Required GPS Software). If a leased computer is utilized in which the operator cannot download files, see the Note at the end of Section 8.0.

- 1) See Attachment A at the end of this SOP for instructions on how to transfer data from the GPS to a personal computer.

**Note:** If you are unable to properly transfer data from the GPS unit to a personal computer, the unit should be shipped to the project-specific contact listed in Section 1.0 where the data will be transferred and the GPS unit then shipped back to the vendor.

## **9.0 SHUTTING DOWN**

This section provides instruction for properly shutting down the GPS unit.

- 1) When shutting down the GPS unit for the day, first click on the "X" in the upper right hand corner.
- 2) You will be prompted to ensure you want to exit TerraSync. Select Yes.
- 3) Power off the GPS unit by pushing the small green button located on the bottom face of the unit.
- 4) Place the GPS unit in its cradle to recharge the battery overnight. Ensure the green charge light is visible on the charging cradle.

## ATTACHMENT A

### How to Transfer Trimble GPS Data between Data Collector and PC

original 11/21/06 (5/1/08 update) – Kevin Moore

***Remember – Coordinate System, Datum, and Units are critical!!!***

#### **Trimble Data Collection Devices:**

Standard rental systems include the Trimble® ProXR/XRS backpack and the newer handheld GeoXT™ or GeoXH™ units. Some of the older backpack system may come with either a RECON “PDA-style” or a TSCe or TSC1 alpha-numeric style data collector.

The software on all of the above units should be Trimble® TerraSync (v 2.53 or higher – current version is 3.20) and to the user should basically look and function similar. The newer units and software versions (which should always be requested when renting) include enhancements for data processing, real-time display functions, and other features.

#### **Data Transfer:**

Trimble provides a free transfer utility program to aid in the transfer of GIS and field data. The Data Transfer Utility is a standalone program that will run on a standard office PC or laptop.

To connect a field data collector such as a RECON, GeoXM, GeoXT, GeoXH, or ProXH, you must first have Microsoft® ActiveSync® installed to allow the PC and the data collector to talk to one another. A standard USB cable is also needed to connect the two devices.

A CD or USB drive is provided with the data collector for use in data transfer. If needed, these programs are also available without charge via the web at:

- **Trimble Data Transfer Utility** (v 1.38) program to download the RECON or GeoXH field data to your PC: <http://www.trimble.com/datatransfer.shtml>

- **ActiveSync** from Microsoft to connect the data collector to the PC. The latest version (v4.5) can be found at: <http://www.microsoft.com/windowsmobile/en-us/downloads/microsoft/activesync-download.msp>

**(see page 2 for data transfer instructions)**

#### To Transfer Data Collected in the Field:

- Install the Data Transfer and ActiveSync software installed on your PC
- Connect the RECON or GeoXH to your PC via an A/B USB cable (blade end and square end type "HP printer" style)
- ActiveSync should auto-detect the connection and recognize the data collector
- Make sure the data file desired is CLOSED in TerraSync prior to transfer
- Connect via ActiveSync as a guest (not a partnership)
- Run the Trimble Data Transfer Utility program on your PC
- Select "**GIS Datalogger on Windows CE**" or similar selection
- Hit the green connect icon to the right - the far right area should say "**Connected to ....**" if successful
- Select the "**Receive**" data tab (under device)
- Select "**Data**" from file types on the right
- Find the file(s) needed for data transfer. You can sort the data files by clicking on the date/time header
- Select or browse to a C-drive folder you can put this file for emailing
- When the file appears on the list, hit the "**Transfer All**"
- Go to your Outlook or other email, send a message to: [Kevin.Moore@tetrattech.com](mailto:Kevin.Moore@tetrattech.com) (or GIS department)
- Attach the file(s) you downloaded from your C-drive. For each TerraSync data file created you should have a packet of multiple data files. All need to be sent as a group – make sure you attach all files (the number of files may vary – examples include: ssf, obx, obs, gix, giw, gis, gip, gic, dd, and car)

#### To Transfer GIS Data from PC to the Field Device (must be converted in Pathfinder Office):

- Obtain GIS file(s) desired from GIS Department and have converted to Trimble extension
- Contact Kevin Moore ([Kevin.Moore@tetrattech.com](mailto:Kevin.Moore@tetrattech.com)) if needed for file conversion and upload support
- The GIS file(s) can be quickly converted if requested and sent back to the field user in the needed "Trimble xxx.imp" extension via email – then quickly downloaded from Outlook to your PC for transfer
- Install the Data Transfer and ActiveSync software installed on your PC
- Connect the RECON or GeoXH to your PC via an A/B USB cable (blade end and square end type "HP printer" style)
- ActiveSync should auto-detect the connection and recognize the data collector
- Connect via ActiveSync as a guest (not a partnership)
- Run the Trimble Data Transfer Utility program on your PC
- Select "**GIS Datalogger on Windows CE**" or similar selection
- Hit the green connect icon to the right - the far right area should say "**Connected to ....**" if successful
- Select the "**Send**" data tab (under device)
- Select "**Data**" from file types on the right (you can also send background files)
- Browse to the location of the data on your PC (obtain the file from Pathfinder Office or from the person who converted the data for field use)
- Select the options as appropriate for the name and location of the data file to go on the data collector (usually you can choose main memory or a data storage card)
- When the file(s) appears on the list, hit the "**Transfer All**"
- Run TerraSync on the field device and open the existing data files. Your transferred file should appear (make sure you have selected Main Memory, Default, or Storage Card as appropriate)



## **STANDARD OPERATING PROCEDURE**

### **SOP-14**

## **DECONTAMINATION OF FIELD SAMPLING EQUIPMENT**

### **1.0 PURPOSE**

This Standard Operating Procedure (SOP) establishes the procedures to be followed when decontaminating non-dedicated field sampling equipment during the field investigations.

### **2.0 REQUIRED FIELD FORMS AND EQUIPMENT**

**Writing utensil (preferably black pen with indelible ink)**

**Non-latex rubber or plastic gloves**

**Field logbook**

**Potable water**

**Deionized water**

**Isopropanol (optional)**

**LiquiNox (or equivalent) lab grade detergent**

**Brushes, spray bottles, and paper towels**

**Container (usually a 5-gallon bucket) to collect and transport decontamination fluids**

### **3.0 DECONTAMINATION PROCEDURES**

- 3.1 Don non-latex gloves and decontaminate sampling equipment (in accordance with the following steps) prior to field sampling and between samples.
- 3.2 Rinse the equipment with potable water. Rinsing may be conducted by spraying with water from a spray bottle or by dipping. Collect the potable water rinsate into a container (bucket).
- 3.3 Prepare the LiquiNox (or similar) wash solution in accordance with the instructions on the container. Wash the equipment with a solution of LiquiNox (or similar) detergent while collecting the wash solution into a container. Use brushes or spray bottles as appropriate for the equipment. If oily residue has accumulated on the sampling equipment, remove the residue with an isopropanol wash and repeat the LiquiNox wash.

- 3.4 Rinse the equipment with potable water. Rinsing may be conducted by spraying with water from a spray bottle or by dipping. Collect the potable water rinsate into a container.
- 3.5 Rinse the equipment with deionized water. Rinsing may be conducted by spraying with water from a spray bottle or by dipping. Collect the deionized water rinsate into a container.
- 3.6 Remove excess water by air drying, shaking, or by wiping with paper towels as necessary.
- 3.7 Document decontamination in the field logbook.
- 3.8 Containerized decontamination solutions will be managed in accordance with the procedures described in SOP-15.

## **STANDARD OPERATING PROCEDURE**

### **SOP-15**

## **MANAGEMENT OF INVESTIGATION-DERIVED WASTE**

### **1.0 PURPOSE**

This Standard Operating Procedure (SOP) describes how investigation-derived waste (IDW) will be collected, segregated, classified, and managed during the field investigations. The following types of IDW will be generated during this investigation:

- Soil sampling residues
- Purge water from well development and sampling
- Decontamination solutions
- Disposed personal protective equipment and clothing (PPE)
- Miscellaneous trash and incidental items

### **2.0 SUPPLIES AND EQUIPMENT**

**Health and safety equipment (with PPE)**

**5-gallon Buckets** (with collected soil or development/purge water)

**Field logbook**

**Writing utensil** (preferably black pen with indelible ink)

**Plastic sheeting and/or tarps**

**55-gallon drums with sealable lids, tools to open and secure drums**

**Work gloves**

**Large poly tanks may be used to store fluid IDW (a pump may be needed to get fluids into tank)**

**IDW labels for drums**

**Plastic garbage bags**

### **3.0 PROCEDURES**

Management of IDW includes the collection, segregation, temporary storage, classification, final disposal, and documentation of the waste-handling activities if necessary. All IDW tanks and drums will be stored at the gated and enclosed IDW staging area. Drums will be stored on pallets with four (or fewer) drums per pallet.

### **3.1      Liquid Wastes**

Liquid wastes that will be generated during the site activities include purged groundwater from well development and sampling and decontamination fluids from decontamination of sampling equipment. These wastes will be collected and containerized in a central location. Purge water can be stored in covered 5-gallon buckets and then buckets can be poured into 55-gallon drums or poly storage tanks until characterized and ultimately disposed. Plastic sheeting or tarps may be used to cover the ground surface.

Groundwater collected from well development and sampling will be stored in 55-gallon steel drums or large poly storage tanks located at the IDW staging area. Drums and tanks will be sealed and labeled (see Attachment 1) on pallets in the enclosed IDW staging area.

### **3.2      Solid Wastes**

Solid wastes that may be generated during site activities include potentially contaminated soil sampling residues. Excess clean soil core/sampling materials will have been returned to the hole and tamped.

Potentially contaminated soil will be placed in 5 –gallon buckets and transferred to 55-gallon steel drums located at the IDW staging area until characterized and ultimate disposal. 55-gallon drums will be sealed and labeled (see Attachment 1).and stored on pallets in the enclosed IDW staging area.

### **3.3      PPE and Incidental Trash**

All PPE wastes and incidental trash materials (e.g., wrapping or packing materials from supply cartons, waste paper) will be decontaminated (if contaminated), double bagged, securely tied shut, and placed in a designated waste receptacle.

## **Attachment 1**

### **IDW DRUM LABEL**

# INVESTIGATION DERIVED WASTE

## GENERATOR INFORMATION:

SITE \_\_\_\_\_ JOB NO. \_\_\_\_\_

LOCATION \_\_\_\_\_

DATE \_\_\_\_\_

DRUM# \_\_\_\_\_

CONTENTS \_\_\_\_\_

VOLUME \_\_\_\_\_

CONTACT \_\_\_\_\_

EMERGENCY PHONE NUMBER \_\_\_\_\_

## **APPENDIX E**

### **LABORATORY DOD ELAP ACCREDITATION**

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**Scope of Accreditation  
For  
Spectrum Analytical, Inc.  
featuring Hanibal Technology, Rhode Island Division**

646 Camp Ave.  
North Kingstown, RI 02852  
Sharyn Lawler  
401-732-3400

In recognition of a successful assessment to ISO/IEC 17025:2005 and the requirements of the DoD Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in the DoD Quality Systems Manual for Environmental Laboratories (DoD QSM v4.2) based on the National Environmental Laboratory Accreditation Conference Chapter 5 Quality Systems Standard (NELAC Voted Revision June 5, 2003), accreditation is granted to Spectrum Analytical, Inc., featuring Hanibal Technology, Rhode Island Division to perform the following tests:

Accreditation granted through: **April 1, 2016**

**Testing – Environmental**

<b>Non-Potable Water</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/MS	EPA 8260C	1,1,1,2-Tetrachloroethane
GC/MS	EPA 8260C	1,1,1-Trichloroethane
GC/MS	EPA 8260C	1,1,2,2-Tetrachloroethane
GC/MS	EPA 8260C	1,1,2-Trichloro-1,2,2-trifluoroethane
GC/MS	EPA 8260C	1,1,2-Trichloroethane
GC/MS	EPA 8260C	1,1-Dichloroethane
GC/MS	EPA 8260C	1,1-Dichloroethene
GC/MS	EPA 8260C	1,1-Dichloropropene
GC/MS	EPA 8260C	1,2,3-Trichlorobenzene
GC/MS	EPA 8260C	1,2,3-Trichloropropane
GC/MS	EPA 8260C	1,2,4-Trichlorobenzene
GC/MS	EPA 8260C	1,2,4-Trimethylbenzene
GC/MS	EPA 8260C	1,2-Dibromo-3-chloropropane
GC/MS	EPA 8260C	1,2-Dibromoethane
GC/MS	EPA 8260C	1,2-Dichlorobenzene
GC/MS	EPA 8260C	1,2-Dichloroethane
GC/MS	EPA 8260C	1,2-Dichloropropane



<b>Non-Potable Water</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/MS	EPA 8260C	1,3,5-Trimethylbenzene
GC/MS	EPA 8260C	1,3-Dichlorobenzene
GC/MS	EPA 8260C	1,3-Dichloropropane
GC/MS	EPA 8260C	1,4-Dichlorobenzene
GC/MS	EPA 8260C	1-Chlorohexane
GC/MS	EPA 8260C	2,2-Dichloropropane
GC/MS	EPA 8260C	2-Butanone
GC/MS	EPA 8260C	2-Chlorotoluene
GC/MS	EPA 8260C	2-Hexanone
GC/MS	EPA 8260C	4-Chlorotoluene
GC/MS	EPA 8260C	4-Isopropyltoluene
GC/MS	EPA 8260C	4-Methyl-2-pentanone
GC/MS	EPA 8260C	Acetone
GC/MS	EPA 8260C	Acetonitrile
GC/MS	EPA 8260C	Acrolein
GC/MS	EPA 8260C	Acrylonitrile
GC/MS	EPA 8260C	Allyl Chloride
GC/MS	EPA 8260C	Benzene
GC/MS	EPA 8260C	Bromobenzene
GC/MS	EPA 8260C	Bromochloromethane
GC/MS	EPA 8260C	Bromodichloromethane
GC/MS	EPA 8260C	Bromoform
GC/MS	EPA 8260C	Bromomethane
GC/MS	EPA 8260C	Carbon disulfide
GC/MS	EPA 8260C	Carbon tetrachloride
GC/MS	EPA 8260C	Chlorobenzene
GC/MS	EPA 8260C	Chloroethane
GC/MS	EPA 8260C	Chloroform
GC/MS	EPA 8260C	Chloromethane
GC/MS	EPA 8260C	cis-1,2-Dichloroethene
GC/MS	EPA 8260C	cis-1,3-Dichloropropene
GC/MS	EPA 8260C	Cyclohexane
GC/MS	EPA 8260C	Dibromochloromethane
GC/MS	EPA 8260C	Dibromomethane
GC/MS	EPA 8260C	Dichlorodifluoromethane





Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 8260C	Diethyl Ether
GC/MS	EPA 8260C	Diisopropyl ether
GC/MS	EPA 8260C	Ethanol
GC/MS	EPA 8260C	Ethylbenzene
GC/MS	EPA 8260C	Ethyl methacrylate
GC/MS	EPA 8260C	Ethyl tert-butyl ether
GC/MS	EPA 8260C	Hexachlorobutadiene
GC/MS	EPA 8260C	Hexachloroethane
GC/MS	EPA 8260C	Iodomethane
GC/MS	EPA 8260C	Isobutyl alcohol
GC/MS	EPA 8260C	Isopropylbenzene
GC/MS	EPA 8260C	m,p-Xylene
GC/MS	EPA 8260C	Methacrylonitrile
GC/MS	EPA 8260C	Methyl acetate
GC/MS	EPA 8260C	Methylcyclohexane
GC/MS	EPA 8260C	Methyl methacrylate
GC/MS	EPA 8260C	Methyl tert-butyl ether
GC/MS	EPA 8260C	Methylene chloride
GC/MS	EPA 8260C	n-Butylbenzene
GC/MS	EPA 8260C	n-Propylbenzene
GC/MS	EPA 8260C	Naphthalene
GC/MS	EPA 8260C	o-Xylene
GC/MS	EPA 8260C	Propionitrile
GC/MS	EPA 8260C	sec-Butylbenzene
GC/MS	EPA 8260C	Styrene
GC/MS	EPA 8260C	tert-Amyl Methyl ether
GC/MS	EPA 8260C	tert-Butyl alcohol
GC/MS	EPA 8260C	tert-Butylbenzene
GC/MS	EPA 8260C	Tetrachloroethene
GC/MS	EPA 8260C	Tetrahydrofuran
GC/MS	EPA 8260C	Toluene
GC/MS	EPA 8260C	trans-1,2-Dichloroethene
GC/MS	EPA 8260C	trans-1,3-Dichloropropene
GC/MS	EPA 8260C	trans-1,4-Dichloro-2-butene
GC/MS	EPA 8260C	Trichloroethene



Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 8260C	Trichlorofluoromethane
GC/MS	EPA 8260C	Vinyl acetate
GC/MS	EPA 8260C	Vinyl chloride
GC/MS	EPA 8260C	Xylene (Total)
GC/MS	EPA 8270D	1,1'-Biphenyl
GC/MS	EPA 8270D	Acetophenone
GC/MS	EPA 8270D	Benzaldehyde
GC/MS	EPA 8270D	Caprolactam
GC/MS	EPA 8270D	1,2,4,5-Tetrachlorobenzene
GC/MS	EPA 8270D	2,3,4,6-Tetrachlorophenol
GC/MS	EPA 8270D	1,2,4-Trichlorobenzene
GC/MS	EPA 8270D	1,2-Dichlorobenzene
GC/MS	EPA 8270D	1,3-Dichlorobenzene
GC/MS	EPA 8270D	1,4-Dichlorobenzene
GC/MS	EPA 8270D	1,4-Dioxane
GC/MS	EPA 8270D	1-Methylnaphthalene
GC/MS	EPA 8270D	2,2'-oxybis(1-Chloropropane)
GC/MS	EPA 8270D	2,4,5-Trichlorophenol
GC/MS	EPA 8270D	2,4,6-Trichlorophenol
GC/MS	EPA 8270D	2,4-Dichlorophenol
GC/MS	EPA 8270D	2,4-Dimethylphenol
GC/MS	EPA 8270D	2,4-Dinitrophenol
GC/MS	EPA 8270D	2,4-Dinitrotoluene
GC/MS	EPA 8270D	2,6-Dinitrotoluene
GC/MS	EPA 8270D	2-Chloronaphthalene
GC/MS	EPA 8270D	2-Chlorophenol
GC/MS	EPA 8270D	2-Methylnaphthalene
GC/MS	EPA 8270D	2-Methylphenol
GC/MS	EPA 8270D	2-Nitroaniline
GC/MS	EPA 8270D	2-Nitrophenol
GC/MS	EPA 8270D	3,3'-Dichlorobenzidine
GC/MS	EPA 8270D	3-Nitroaniline
GC/MS	EPA 8270D	4,6-Dinitro-2-methylphenol
GC/MS	EPA 8270D	4-Bromophenyl-phenylether
GC/MS	EPA 8270D	4-Chloro-3-methylphenol



Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 8270D	4-Chloroaniline
GC/MS	EPA 8270D	4-Chlorophenyl-phenylether
GC/MS	EPA 8270D	4-Methylphenol
GC/MS	EPA 8270D	4-Nitroaniline
GC/MS	EPA 8270D	4-Nitrophenol
GC/MS	EPA 8270D	Acenaphthene
GC/MS	EPA 8270D	Acenaphthylene
GC/MS	EPA 8270D	Aniline
GC/MS	EPA 8270D	Anthracene
GC/MS	EPA 8270D	Atrazine
GC/MS	EPA 8270D	Azobenzene
GC/MS	EPA 8270D	Benzidine
GC/MS	EPA 8270D	Benzyl Alcohol
GC/MS	EPA 8270D	Benzo(a)anthracene
GC/MS	EPA 8270D	Benzo(a)pyrene
GC/MS	EPA 8270D	Benzo(b)fluoranthene
GC/MS	EPA 8270D	Benzo(g,h,i)perylene
GC/MS	EPA 8270D	Benzo(k)fluoranthene
GC/MS	EPA 8270D	Bis(2-chloroethoxy)methane
GC/MS	EPA 8270D	Bis(2-chloroethyl)ether
GC/MS	EPA 8270D	Bis(2-ethylhexyl)phthalate
GC/MS	EPA 8270D	Butylbenzylphthalate
GC/MS	EPA 8270D	Carbazole
GC/MS	EPA 8270D	Chrysene
GC/MS	EPA 8270D	Di-n-butylphthalate
GC/MS	EPA 8270D	Dibenzofuran
GC/MS	EPA 8270D	Diethylphthalate
GC/MS	EPA 8270D	Dimethylphthalate
GC/MS	EPA 8270D	Di-n-octylphthalate
GC/MS	EPA 8270D	Dibenzo(a,h)anthracene
GC/MS	EPA 8270D	Fluoranthene
GC/MS	EPA 8270D	Fluorene
GC/MS	EPA 8270D	Hexachlorobenzene
GC/MS	EPA 8270D	Hexachlorobutadiene
GC/MS	EPA 8270D	Hexachlorocyclopentadiene



<b>Non-Potable Water</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/MS	EPA 8270D	Hexachloroethane
GC/MS	EPA 8270D	Indeno(1,2,3-cd)pyrene
GC/MS	EPA 8270D	Isophorone
GC/MS	EPA 8270D	N-Nitroso-di-n-propylamine
GC/MS	EPA 8270D	Nitrobenzene
GC/MS	EPA 8270D	Pentachlorophenol
GC/MS	EPA 8270D	N-Nitrosodimethylamine
GC/MS	EPA 8270D	N-Nitrosodiphenylamine
GC/MS	EPA 8270D	Naphthalene
GC/MS	EPA 8270D	Phenanthrene
GC/MS	EPA 8270D	Phenol
GC/MS	EPA 8270D	Pyrene
GC/MS	EPA 8270D	Pyridine
GC/ECD	EPA 8011	1,2-Dibromoethane (EDB)
GC/ECD	EPA 8011	1,2-Dibromo-3-chloropropane (DBCP)
GC/ECD	EPA 8081B	4,4'-DDD
GC/ECD	EPA 8081B	4,4'-DDE
GC/ECD	EPA 8081B	4,4'-DDT
GC/ECD	EPA 8081B	Aldrin
GC/ECD	EPA 8081B	alpha-BHC
GC/ECD	EPA 8081B	alpha-Chlordane
GC/ECD	EPA 8081B	beta-BHC
GC/ECD	EPA 8081B	delta-BHC
GC/ECD	EPA 8081B	Dieldrin
GC/ECD	EPA 8081B	Endosulfan I
GC/ECD	EPA 8081B	Endosulfan II
GC/ECD	EPA 8081B	Endosulfan sulfate
GC/ECD	EPA 8081B	Endrin
GC/ECD	EPA 8081B	Endrin aldehyde
GC/ECD	EPA 8081B	Endrin ketone
GC/ECD	EPA 8081B	gamma-BHC (Lindane)
GC/ECD	EPA 8081B	gamma-Chlordane
GC/ECD	EPA 8081B	Heptachlor
GC/ECD	EPA 8081B	Heptachlor epoxide
GC/ECD	EPA 8081B	Methoxychlor



<b>Non-Potable Water</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/ECD	EPA 8081B	Toxaphene
GC/ECD	EPA 8081B	Chlordane (technical)
GC/ECD	EPA 8082A	2,2',4,5,5'-Pentachlorobiphenyl
GC/ECD	EPA 8082A	2,3,3',4,4'-Pentachlorobiphenyl
GC/ECD	EPA 8082A	2,3,4,4',5-Pentachlorobiphenyl
GC/ECD	EPA 8082A	2,3',4,4',5'-Pentachlorobiphenyl
GC/ECD	EPA 8082A	2,3',4,4',5'-Pentachlorobiphenyl
GC/ECD	EPA 8082A	3,3',4,4',5-Pentachlorobiphenyl
GC/ECD	EPA 8082A	2,2',3,3',4,4'-Hexachlorobiphenyl
GC/ECD	EPA 8082A	2,2',3,4,4',5'-Hexachlorobiphenyl
GC/ECD	EPA 8082A	2,2',4,4',5,5'-Hexachlorobiphenyl
GC/ECD	EPA 8082A	2,3,3',4,4',5-Hexachlorobiphenyl
GC/ECD	EPA 8082A	2,3,3',4,4',5'-Hexachlorobiphenyl
GC/ECD	EPA 8082A	2,3',4,4',5-Pentachlorobiphenyl
GC/ECD	EPA 8082A	3,3',4,4',5,5'-Hexachlorobiphenyl
GC/ECD	EPA 8082A	2,2',3,3',4,4',5-Heptachlorobiphenyl
GC/ECD	EPA 8082A	2,2',5-Trichlorobiphenyl
GC/ECD	EPA 8082A	2,2',3,4,4',5,5'-Heptachlorobiphenyl
GC/ECD	EPA 8082A	2,2',3,4,4',5',6-Heptachlorobiphenyl
GC/ECD	EPA 8082A	2,2',3,3',5,6'-Hexachlorobiphenyl
GC/ECD	EPA 8082A	2,2',3,4',5,5',6-Heptachlorobiphenyl
GC/ECD	EPA 8082A	2,2',3,4,4',6'-Hexachlorobiphenyl
GC/ECD	EPA 8082A	2,2',3,3',4,4',5,6-Octachlorobiphenyl
GC/ECD	EPA 8082A	2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl
GC/ECD	EPA 8082A	Decachlorobiphenyl
GC/ECD	EPA 8082A	2,4,4'-Trichlorobiphenyl
GC/ECD	EPA 8082A	2,2',3,5'-Tetrachlorobiphenyl
GC/ECD	EPA 8082A	2,2',4,5'-Tetrachlorobiphenyl
GC/ECD	EPA 8082A	2,2',5,5'-Tetrachlorobiphenyl
GC/ECD	EPA 8082A	2,3',4,4'-Tetrachlorobiphenyl
GC/ECD	EPA 8082A	3,3',4,4'-Tetrachlorobiphenyl
GC/ECD	EPA 8082A	2,4'-Dichlorobiphenyl
GC/ECD	EPA 8082A	3,4,4',5-Tetrachlorobiphenyl
GC/ECD	EPA 8082A	2,2',3,4,5'-Pentachlorobiphenyl
GC/ECD	EPA 8082A	Aroclor-1016



<b>Non-Potable Water</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/ECD	EPA 8082A	Aroclor-1221
GC/ECD	EPA 8082A	Aroclor-1232
GC/ECD	EPA 8082A	Aroclor-1242
GC/ECD	EPA 8082A	Aroclor-1248
GC/ECD	EPA 8082A	Aroclor-1254
GC/ECD	EPA 8082A	Aroclor-1260
GC/ECD	EPA 8082A	Aroclor-1262
GC/ECD	EPA 8082A	Aroclor-1268
GC/MS/SIM	EPA 680Mod	Decachlorobiphenyl
GC/MS/SIM	EPA 680Mod	Dichlorobiphenyl
GC/MS/SIM	EPA 680Mod	Heptachlorobiphenyl
GC/MS/SIM	EPA 680Mod	Hexachlorobiphenyl
GC/MS/SIM	EPA 680Mod	Monochlorobiphenyl
GC/MS/SIM	EPA 680Mod	Nonachlorobiphenyl
GC/MS/SIM	EPA 680Mod	Octachlorobiphenyl
GC/MS/SIM	EPA 680Mod	Pentachlorobiphenyl
GC/MS/SIM	EPA 680Mod	Tetrachlorobiphenyl
GC/MS/SIM	EPA 680Mod	Trichlorobiphenyl
GC/MS/SIM	EPA 680Mod	Total PCBs
GC/ECD	EPA 8151A	2,4,5-T
GC/ECD	EPA 8151A	2,4,5-TP (Silvex)
GC/ECD	EPA 8151A	2,4-D
GC/ECD	EPA 8151A	2,4-DB
GC/ECD	EPA 8151A	Dalapon
GC/ECD	EPA 8151A	Dicamba
GC/ECD	EPA 8151A	Dichlorprop
GC/ECD	EPA 8151A	Dinoseb
GC/ECD	EPA 8151A	MCPA
GC/ECD	EPA 8151A	MCPP
GC/FID	EPA 8015D	Diesel Range Organics
GC/FID	EPA 8015D	Gasoline Range Organics
ICP/AES	EPA 6010C	Aluminum
ICP/AES	EPA 6010C	Antimony
ICP/AES	EPA 6010C	Arsenic
ICP/AES	EPA 6010C	Barium



<b>Non-Potable Water</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
ICP/AES	EPA 6010C	Beryllium
ICP/AES	EPA 6010C	Boron
ICP/AES	EPA 6010C	Cadmium
ICP/AES	EPA 6010C	Calcium
ICP/AES	EPA 6010C	Chromium
ICP/AES	EPA 6010C	Cobalt
ICP/AES	EPA 6010C	Copper
ICP/AES	EPA 6010C	Iron
ICP/AES	EPA 6010C	Lead
ICP/AES	EPA 6010C	Magnesium
ICP/AES	EPA 6010C	Manganese
ICP/AES	EPA 6010C	Molybdenum
ICP/AES	EPA 6010C	Nickel
ICP/AES	EPA 6010C	Potassium
ICP/AES	EPA 6010C	Selenium
ICP/AES	EPA 6010C	Silver
ICP/AES	EPA 6010C	Sodium
ICP/AES	EPA 6010C	Thallium
ICP/AES	EPA 6010C	Tin
ICP/AES	EPA 6010C	Vanadium
ICP/AES	EPA 6010C	Zinc
ICP/AES	SM 2340 B-1997	Hardness, Ca/Mg (As CaCO <sub>3</sub> ) BY CALCULATION
ICP/MS	EPA 6020A	Aluminum
ICP/MS	EPA 6020A	Antimony
ICP/MS	EPA 6020A	Arsenic
ICP/MS	EPA 6020A	Barium
ICP/MS	EPA 6020A	Beryllium
ICP/MS	EPA 6020A	Cadmium
ICP/MS	EPA 6020A	Calcium
ICP/MS	EPA 6020A	Chromium
ICP/MS	EPA 6020A	Cobalt
ICP/MS	EPA 6020A	Copper
ICP/MS	EPA 6020A	Iron
ICP/MS	EPA 6020A	Lead
ICP/MS	EPA 6020A	Magnesium



**Non-Potable Water**

<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
ICP/MS	EPA 6020A	Manganese
ICP/MS	EPA 6020A	Nickel
ICP/MS	EPA 6020A	Potassium
ICP/MS	EPA 6020A	Selenium
ICP/MS	EPA 6020A	Silver
ICP/MS	EPA 6020A	Sodium
ICP/MS	EPA 6020A	Thallium
ICP/MS	EPA 6020A	Vanadium
ICP/MS	EPA 6020A	Zinc
CVAA	EPA 7470A	Mercury
FIA	EPA 9012B	Total Cyanide
IC	EPA 9056A	Bromide
IC	EPA 9056A	Chloride
IC	EPA 9056A	Fluoride
IC	EPA 9056A	Nitrogen, Nitrate (As N)
IC	EPA 9056A	Nitrogen, Nitrite (As N)
IC	EPA 9056A	ortho-Phosphate (As P)
UV/VIS	SM 4500 P B(5)+E _1999	Total Phosphorus
IC	EPA 9056A	Sulfate
IC	EPA 300.0 mod.	Acetic Acid
IC	EPA 300.0 mod.	Butyric Acid
IC	EPA 300.0 mod.	Lactic Acid
IC	EPA 300.0 mod.	Propionic Acid
IC	EPA 300.0 mod.	Pyruvic Acid
UV/VIS	SM 4500 S2- D _2000	Sulfide
combustion/IR	EPA 9060A	Organic Carbon, Total
UV/VIS	SM 3500 Cr B _2009	Chromium, Hexavalent
Pensky-Marten	EPA 1010A	Ignitability
pH meter	SM 4500 H+B _2000	pH
Titration	SM 2320 B _1997	Alkalinity, Total (As CaCO <sub>3</sub> )
Gravimetric	SM 2540 C _1997	Total Dissolved Solids
Gravimetric	SM 2540 D _1997	Total Suspended Solids
Gravimetric	EPA 1664A	Oil & Grease, Total Recoverable
Conductivity Meter	EPA 120.1	Specific Conductance
UV/VIS	SM 5220 D _1997	Chemical Oxygen Demand



<b>Non-Potable Water</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
UV/VIS	SM 3500 Fe B _1997	Ferrous Iron
GC/FID	RSK-175	Ethane
GC/FID	RSK-175	Ethene
GC/FID	RSK-175	Methane
<b>Preparation</b>	<b>Method</b>	<b>Type</b>
Organic Preparation	EPA 3510C	Separatory Funnel
Organic Preparation	EPA 3520C	Continuous Liquid Liquid
Inorganic Preparation	EPA 3005A	Hotblock
Inorganic Preparation	EPA 3010A	Hotblock
Volatile Organic Preparation	EPA 5030B	Purge and Trap
Organic Extract Cleanup	EPA 3660B	Sulfur cleanup
Organic Extract Cleanup	EPA 3665A	Acid cleanup

<b>Solid and Chemical Waste</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
CVAA	EPA 7471B	Mercury
FIA	EPA 9012B	Total Cyanide
Titration	WALKLEY BLACK	Organic Carbon, Total
Combustion/IR	EPA 9060A	Organic Carbon, Total
Combustion/IR	Lloyd Kahn	Organic Carbon, Total
UV/VIS	EPA 7196A	Chromium, Hexavalent
Oven	ASTM D2216	Percent moisture
pH meter	EPA 9045D	pH
ICP/AES	EPA 6010C	Aluminum
ICP/AES	EPA 6010C	Antimony
ICP/AES	EPA 6010C	Arsenic
ICP/AES	EPA 6010C	Barium
ICP/AES	EPA 6010C	Beryllium
ICP/AES	EPA 6010C	Boron
ICP/AES	EPA 6010C	Cadmium
ICP/AES	EPA 6010C	Calcium
ICP/AES	EPA 6010C	Chromium
ICP/AES	EPA 6010C	Cobalt



**Solid and Chemical Waste**

<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
ICP/AES	EPA 6010C	Copper
ICP/AES	EPA 6010C	Iron
ICP/AES	EPA 6010C	Lead
ICP/AES	EPA 6010C	Magnesium
ICP/AES	EPA 6010C	Manganese
ICP/AES	EPA 6010C	Molybdenum
ICP/AES	EPA 6010C	Nickel
ICP/AES	EPA 6010C	Potassium
ICP/AES	EPA 6010C	Selenium
ICP/AES	EPA 6010C	Silver
ICP/AES	EPA 6010C	Sodium
ICP/AES	EPA 6010C	Thallium
ICP/AES	EPA 6010C	Tin
ICP/AES	EPA 6010C	Vanadium
ICP/AES	EPA 6010C	Zinc
ICP/MS	EPA 6020A	Aluminum
ICP/MS	EPA 6020A	Antimony
ICP/MS	EPA 6020A	Arsenic
ICP/MS	EPA 6020A	Barium
ICP/MS	EPA 6020A	Beryllium
ICP/MS	EPA 6020A	Cadmium
ICP/MS	EPA 6020A	Calcium
ICP/MS	EPA 6020A	Chromium
ICP/MS	EPA 6020A	Cobalt
ICP/MS	EPA 6020A	Copper
ICP/MS	EPA 6020A	Iron
ICP/MS	EPA 6020A	Lead
ICP/MS	EPA 6020A	Magnesium
ICP/MS	EPA 6020A	Manganese
ICP/MS	EPA 6020A	Nickel
ICP/MS	EPA 6020A	Potassium
ICP/MS	EPA 6020A	Selenium
ICP/MS	EPA 6020A	Silver
ICP/MS	EPA 6020A	Sodium



<b>Solid and Chemical Waste</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
ICP/MS	EPA 6020A	Thallium
ICP/MS	EPA 6020A	Vanadium
ICP/MS	EPA 6020A	Zinc
GC/FID	EPA 8015D	Diesel Range Organics
GC/FID	EPA 8015D	Gasoline Range Organics
GC/ECD	EPA 8082A	Aroclor-1016
GC/ECD	EPA 8082A	Aroclor-1221
GC/ECD	EPA 8082A	Aroclor-1232
GC/ECD	EPA 8082A	Aroclor-1242
GC/ECD	EPA 8082A	Aroclor-1248
GC/ECD	EPA 8082A	Aroclor-1254
GC/ECD	EPA 8082A	Aroclor-1260
GC/ECD	EPA 8082A	Aroclor-1262
GC/ECD	EPA 8082A	Aroclor-1268
GC/ECD	EPA 8082A	2,2',4,5,5'-Pentachlorobiphenyl
GC/ECD	EPA 8082A	2,3,3',4,4'-Pentachlorobiphenyl
GC/ECD	EPA 8082A	2,3,4,4',5-Pentachlorobiphenyl
GC/ECD	EPA 8082A	2,3',4,4',5'-Pentachlorobiphenyl
GC/ECD	EPA 8082A	2,3',4,4',5'-Pentachlorobiphenyl
GC/ECD	EPA 8082A	3,3',4,4',5-Pentachlorobiphenyl
GC/ECD	EPA 8082A	2,2',3,3',4,4'-Hexachlorobiphenyl
GC/ECD	EPA 8082A	2,2',3,4,4',5'-Hexachlorobiphenyl
GC/ECD	EPA 8082A	2,2',4,4',5,5'-Hexachlorobiphenyl
GC/ECD	EPA 8082A	2,3,3',4,4',5-Hexachlorobiphenyl
GC/ECD	EPA 8082A	2,3,3',4,4',5'-Hexachlorobiphenyl
GC/ECD	EPA 8082A	2,3',4,4',5-Pentachlorobiphenyl
GC/ECD	EPA 8082A	3,3',4,4',5,5'-Hexachlorobiphenyl
GC/ECD	EPA 8082A	2,2',3,3',4,4',5-Heptachlorobiphenyl
GC/ECD	EPA 8082A	2,2',5-Trichlorobiphenyl
GC/ECD	EPA 8082A	2,2',3,4,4',5,5'-Heptachlorobiphenyl
GC/ECD	EPA 8082A	2,2',3,4,4',5',6-Heptachlorobiphenyl
GC/ECD	EPA 8082A	2,2',3,3',5,6'-Hexachlorobiphenyl
GC/ECD	EPA 8082A	2,2',3,4',5,5',6-Heptachlorobiphenyl
GC/ECD	EPA 8082A	2,2',3,4,4',6'-Hexachlorobiphenyl



<b>Solid and Chemical Waste</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/ECD	EPA 8082A	2,2',3,3',4,4',5,6-Octachlorobiphenyl
GC/ECD	EPA 8082A	2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl
GC/ECD	EPA 8082A	Decachlorobiphenyl
GC/ECD	EPA 8082A	2,4,4'-Trichlorobiphenyl
GC/ECD	EPA 8082A	2,2',3,5'-Tetrachlorobiphenyl
GC/ECD	EPA 8082A	2,2',4,5'-Tetrachlorobiphenyl
GC/ECD	EPA 8082A	2,2',5,5'-Tetrachlorobiphenyl
GC/ECD	EPA 8082A	2,3',4,4'-Tetrachlorobiphenyl
GC/ECD	EPA 8082A	3,3',4,4'-Tetrachlorobiphenyl
GC/ECD	EPA 8082A	2,4'-Dichlorobiphenyl
GC/ECD	EPA 8082A	3,4,4',5-Tetrachlorobiphenyl
GC/ECD	EPA 8082A	2,2',3,4,5'-Pentachlorobiphenyl
GC/MS/SIM	EPA 680Mod	Decachlorobiphenyl
GC/MS/SIM	EPA 680Mod	Dichlorobiphenyl
GC/MS/SIM	EPA 680Mod	Heptachlorobiphenyl
GC/MS/SIM	EPA 680Mod	Hexachlorobiphenyl
GC/MS/SIM	EPA 680Mod	Monochlorobiphenyl
GC/MS/SIM	EPA 680Mod	Nonachlorobiphenyl
GC/MS/SIM	EPA 680Mod	Octachlorobiphenyl
GC/MS/SIM	EPA 680Mod	Pentachlorobiphenyl
GC/MS/SIM	EPA 680Mod	Tetrachlorobiphenyl
GC/MS/SIM	EPA 680Mod	Trichlorobiphenyl
GC/MS/SIM	EPA 680Mod	Total PCBs
GC/ECD	EPA 8081B	4,4'-DDD
GC/ECD	EPA 8081B	4,4'-DDE
GC/ECD	EPA 8081B	4,4'-DDT
GC/ECD	EPA 8081B	Aldrin
GC/ECD	EPA 8081B	alpha-BHC
GC/ECD	EPA 8081B	alpha-Chlordane
GC/ECD	EPA 8081B	beta-BHC
GC/ECD	EPA 8081B	delta-BHC
GC/ECD	EPA 8081B	Dieldrin
GC/ECD	EPA 8081B	Endosulfan I
GC/ECD	EPA 8081B	Endosulfan II



<b>Solid and Chemical Waste</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/ECD	EPA 8081B	Endosulfan sulfate
GC/ECD	EPA 8081B	Endrin
GC/ECD	EPA 8081B	Endrin aldehyde
GC/ECD	EPA 8081B	Endrin ketone
GC/ECD	EPA 8081B	gamma-BHC (Lindane)
GC/ECD	EPA 8081B	gamma-Chlordane
GC/ECD	EPA 8081B	Heptachlor
GC/ECD	EPA 8081B	Heptachlor epoxide
GC/ECD	EPA 8081B	Methoxychlor
GC/ECD	EPA 8081B	Toxaphene
GC/ECD	EPA 8081B	Chlordane (technical)
GC/MS	EPA 8260C	1,1,1,2-Tetrachloroethane
GC/MS	EPA 8260C	1,1,1-Trichloroethane
GC/MS	EPA 8260C	1,1,2,2-Tetrachloroethane
GC/MS	EPA 8260C	1,1,2-Trichloro-1,2,2-trifluoroethane
GC/MS	EPA 8260C	1,1,2-Trichloroethane
GC/MS	EPA 8260C	1,1-Dichloroethane
GC/MS	EPA 8260C	1,1-Dichloroethene
GC/MS	EPA 8260C	1,1-Dichloropropene
GC/MS	EPA 8260C	1,2,3-Trichlorobenzene
GC/MS	EPA 8260C	1,2,3-Trichloropropane
GC/MS	EPA 8260C	1,2,4-Trichlorobenzene
GC/MS	EPA 8260C	1,2,4-Trimethylbenzene
GC/MS	EPA 8260C	1,2-Dibromo-3-chloropropane
GC/MS	EPA 8260C	1,2-Dibromoethane
GC/MS	EPA 8260C	1,2-Dichlorobenzene
GC/MS	EPA 8260C	1,2-Dichloroethane
GC/MS	EPA 8260C	1,2-Dichloropropane
GC/MS	EPA 8260C	1,3,5-Trimethylbenzene
GC/MS	EPA 8260C	1,3-Dichlorobenzene
GC/MS	EPA 8260C	1,3-Dichloropropane
GC/MS	EPA 8260C	1,4-Dichlorobenzene
GC/MS	EPA 8260C	1,4-Dioxane
GC/MS	EPA 8260C	1-Chlorohexane



<b>Solid and Chemical Waste</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/MS	EPA 8260C	2,2-Dichloropropane
GC/MS	EPA 8260C	2-Butanone
GC/MS	EPA 8260C	2-Chlorotoluene
GC/MS	EPA 8260C	2-Hexanone
GC/MS	EPA 8260C	4-Chlorotoluene
GC/MS	EPA 8260C	4-Isopropyltoluene
GC/MS	EPA 8260C	4-Methyl-2-pentanone
GC/MS	EPA 8260C	Acetone
GC/MS	EPA 8260C	Acetonitrile
GC/MS	EPA 8260C	Acrolein
GC/MS	EPA 8260C	Acrylonitrile
GC/MS	EPA 8260C	Allyl Chloride
GC/MS	EPA 8260C	Benzene
GC/MS	EPA 8260C	Bromobenzene
GC/MS	EPA 8260C	Bromochloromethane
GC/MS	EPA 8260C	Bromodichloromethane
GC/MS	EPA 8260C	Bromoform
GC/MS	EPA 8260C	Bromomethane
GC/MS	EPA 8260C	Carbon disulfide
GC/MS	EPA 8260C	Carbon tetrachloride
GC/MS	EPA 8260C	Chlorobenzene
GC/MS	EPA 8260C	Chloroethane
GC/MS	EPA 8260C	Chloroform
GC/MS	EPA 8260C	Chloromethane
GC/MS	EPA 8260C	cis-1,2-Dichloroethene
GC/MS	EPA 8260C	cis-1,3-Dichloropropene
GC/MS	EPA 8260C	Cyclohexane
GC/MS	EPA 8260C	Dibromochloromethane
GC/MS	EPA 8260C	Dibromomethane
GC/MS	EPA 8260C	Dichlorodifluoromethane
GC/MS	EPA 8260C	Diethyl Ether
GC/MS	EPA 8260C	Diisopropyl ether
GC/MS	EPA 8260C	Ethanol
GC/MS	EPA 8260C	Ethylbenzene



<b>Solid and Chemical Waste</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/MS	EPA 8260C	Ethyl methacrylate
GC/MS	EPA 8260C	Ethyl tert-butyl ether
GC/MS	EPA 8260C	Hexachlorobutadiene
GC/MS	EPA 8260C	Hexachloroethane
GC/MS	EPA 8260C	Iodomethane
GC/MS	EPA 8260C	Isobutyl alcohol
GC/MS	EPA 8260C	Isopropylbenzene
GC/MS	EPA 8260C	m,p-Xylene
GC/MS	EPA 8260C	Methacrylonitrile
GC/MS	EPA 8260C	Methyl acetate
GC/MS	EPA 8260C	Methylcyclohexane
GC/MS	EPA 8260C	Methyl methacrylate
GC/MS	EPA 8260C	Methyl tert-butyl ether
GC/MS	EPA 8260C	Methylene chloride
GC/MS	EPA 8260C	n-Butylbenzene
GC/MS	EPA 8260C	n-Propylbenzene
GC/MS	EPA 8260C	Naphthalene
GC/MS	EPA 8260C	o-Xylene
GC/MS	EPA 8260C	Propionitrile
GC/MS	EPA 8260C	sec-Butylbenzene
GC/MS	EPA 8260C	Styrene
GC/MS	EPA 8260C	tert-Amyl Methyl ether
GC/MS	EPA 8260C	tert-Butyl alcohol
GC/MS	EPA 8260C	tert-Butylbenzene
GC/MS	EPA 8260C	Tetrachloroethene
GC/MS	EPA 8260C	Tetrahydrofuran
GC/MS	EPA 8260C	Toluene
GC/MS	EPA 8260C	trans-1,2-Dichloroethene
GC/MS	EPA 8260C	trans-1,3-Dichloropropene
GC/MS	EPA 8260C	trans-1,4-Dichloro-2-butene
GC/MS	EPA 8260C	Trichloroethene
GC/MS	EPA 8260C	Trichlorofluoromethane
GC/MS	EPA 8260C	Vinyl acetate
GC/MS	EPA 8260C	Vinyl chloride



<b>Solid and Chemical Waste</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/MS	EPA 8260C	Xylene (Total)
GC/MS	EPA 8270D	Acetophenone
GC/MS	EPA 8270D	Benzaldehyde
GC/MS	EPA 8270D	Caprolactam
GC/MS	EPA 8270D	1,1'-Biphenyl
GC/MS	EPA 8270D	1,2,4,5-Tetrachlorobenzene
GC/MS	EPA 8270D	2,3,4,6-Tetrachlorophenol
GC/MS	EPA 8270D	1,4-Dioxane
GC/MS	EPA 8270D	1,2,4-Trichlorobenzene
GC/MS	EPA 8270D	1,2-Dichlorobenzene
GC/MS	EPA 8270D	1,3-Dichlorobenzene
GC/MS	EPA 8270D	1,4-Dichlorobenzene
GC/MS	EPA 8270D	1-Methylnaphthalene
GC/MS	EPA 8270D	2,2'-oxybis (1-Chloropropane)
GC/MS	EPA 8270D	2,4,5-Trichlorophenol
GC/MS	EPA 8270D	2,4,6-Trichlorophenol
GC/MS	EPA 8270D	2,4-Dichlorophenol
GC/MS	EPA 8270D	2,4-Dimethylphenol
GC/MS	EPA 8270D	2,4-Dinitrophenol
GC/MS	EPA 8270D	2,4-Dinitrotoluene
GC/MS	EPA 8270D	2,6-Dinitrotoluene
GC/MS	EPA 8270D	2-Chloronaphthalene
GC/MS	EPA 8270D	2-Chlorophenol
GC/MS	EPA 8270D	2-Methylnaphthalene
GC/MS	EPA 8270D	2-Methylphenol
GC/MS	EPA 8270D	2-Nitroaniline
GC/MS	EPA 8270D	2-Nitrophenol
GC/MS	EPA 8270D	3,3'-Dichlorobenzidine
GC/MS	EPA 8270D	3-Nitroaniline
GC/MS	EPA 8270D	4,6-Dinitro-2-methylphenol
GC/MS	EPA 8270D	4-Bromophenyl-phenylether
GC/MS	EPA 8270D	4-Chloro-3-methylphenol
GC/MS	EPA 8270D	4-Chloroaniline
GC/MS	EPA 8270D	4-Chlorophenyl-phenylether





<b>Solid and Chemical Waste</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/MS	EPA 8270D	4-Methylphenol
GC/MS	EPA 8270D	4-Nitroaniline
GC/MS	EPA 8270D	4-Nitrophenol
GC/MS	EPA 8270D	Acenaphthene
GC/MS	EPA 8270D	Acenaphthylene
GC/MS	EPA 8270D	Aniline
GC/MS	EPA 8270D	Anthracene
GC/MS	EPA 8270D	Atrazine
GC/MS	EPA 8270D	Azobenzene
GC/MS	EPA 8270D	Benzyl Alcohol
GC/MS	EPA 8270D	Benzo(a)anthracene
GC/MS	EPA 8270D	Benzo(a)pyrene
GC/MS	EPA 8270D	Benzo(b)fluoranthene
GC/MS	EPA 8270D	Benzo(g,h,i)perylene
GC/MS	EPA 8270D	Benzo(k)fluoranthene
GC/MS	EPA 8270D	Bis(2-chloroethoxy)methane
GC/MS	EPA 8270D	Bis(2-chloroethyl)ether
GC/MS	EPA 8270D	Bis(2-ethylhexyl)phthalate
GC/MS	EPA 8270D	Butylbenzylphthalate
GC/MS	EPA 8270D	Carbazole
GC/MS	EPA 8270D	Chrysene
GC/MS	EPA 8270D	Di-n-butylphthalate
GC/MS	EPA 8270D	Dibenzofuran
GC/MS	EPA 8270D	Diethylphthalate
GC/MS	EPA 8270D	Dimethylphthalate
GC/MS	EPA 8270D	Di-n-octylphthalate
GC/MS	EPA 8270D	Dibenzo(a,h)anthracene
GC/MS	EPA 8270D	Fluoranthene
GC/MS	EPA 8270D	Fluorene
GC/MS	EPA 8270D	Hexachlorobenzene
GC/MS	EPA 8270D	Hexachlorobutadiene
GC/MS	EPA 8270D	Hexachlorocyclopentadiene
GC/MS	EPA 8270D	Hexachloroethane
GC/MS	EPA 8270D	Indeno(1,2,3-cd)pyrene



<b>Solid and Chemical Waste</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
GC/MS	EPA 8270D	Isophorone
GC/MS	EPA 8270D	N-Nitroso-di-n-propylamine
GC/MS	EPA 8270D	Nitrobenzene
GC/MS	EPA 8270D	Pentachlorophenol
GC/MS	EPA 8270D	N-Nitrosodimethylamine
GC/MS	EPA 8270D	N-Nitrosodiphenylamine
GC/MS	EPA 8270D	Naphthalene
GC/MS	EPA 8270D	Phenanthrene
GC/MS	EPA 8270D	Phenol
GC/MS	EPA 8270D	Pyrene
GC/ECD	EPA 8151A	2,4,5-T
GC/ECD	EPA 8151A	2,4,5-TP (Silvex)
GC/ECD	EPA 8151A	2,4-D
GC/ECD	EPA 8151A	2,4-DB
GC/ECD	EPA 8151A	Dalapon
GC/ECD	EPA 8151A	Dicamba
GC/ECD	EPA 8151A	Dichlorprop
GC/ECD	EPA 8151A	Dinoseb
GC/ECD	EPA 8151A	MCPA
GC/ECD	EPA 8151A	MCPP
UV/VIS	EPA 9031 Mod	Extractable Sulfides
<b>Preparation</b>	<b>Method</b>	<b>Type</b>
Organic Preparation	EPA 3550B	Sonication
Inorganics Preparation	EPA 3050B	Hotblock
Organic Preparation	EPA 3545	Pressurized Fluid
Organic Preparation	EPA 3540C	Soxhlet
Volatile Organics Preparation	EPA 5035A	Closed System Purge and Trap
Inorganics Preparation	EPA 3060A	Alkaline Digestion
Preparation	EPA 1311	Toxicity Characteristic Leaching Procedure
Preparation	ASTM D3987	Shake ext of solid waste with water
Organic Extract Cleanup	EPA 3660B	Sulfur cleanup
Organic Extract Cleanup	EPA 3665A	Acid cleanup



Notes:

- 1) This laboratory offers commercial testing service.

Approved by: \_\_\_\_\_

A handwritten signature in black ink, appearing to read 'R. Douglas Leonard', written over a horizontal line.

R. Douglas Leonard  
Chief Technical Officer

Date: February 10, 2014

## **APPENDIX F**

### **SELECTION OF PROJECT SCREENING LEVELS (WORKSHEET #9 BACKUP)**

TABLE F-1

## SOIL ANALYTES AND PROJECT SCREENING LEVELS

CAS No.	Chemical	RSL RES <sup>(1)</sup> (mg/kg)	RISK BASIS	RSL RES-ADJ <sup>(2)</sup> (mg/kg)	RIDEM R-DEC <sup>(3)</sup> (mg/kg)	RIDEM GA LEACHABILITY <sup>(3)</sup> (mg/kg)	RIDEM GB LEACHABILITY <sup>(3)</sup> (mg/kg)	Minimum Criterion (mg/kg)	Minimum Criterion Reference (mg/kg)
<b>PETROLEUM HYDROCARBONS</b>									
--	TPH-GRO (MTBE through naphthalene)	--		--	500	2500	2500	500	R-DEC
--	TPH-DRO (C9-C40)	--		--	500	2500	2500	500	R-DEC

1 - United States Environmental Protection Agency (USEPA) Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites, May 2014.

Residential soil screening levels are based on a lifetime cancer risk of 1E-06 for carcinogens (C) or a hazard quotient (HQ) of 1 for noncarcinogens (N).

2 - RSLs for noncarcinogens were adjusted (i.e., divided by 10) to represent an HQ of 0.1.

3 - Rhode Island Department of Environmental Management (RIDEM), DEM-DSR-01-93, November 2011. R-DEC - Residential Direct Exposure Criterion.

**TABLE F-2**  
**GROUNDWATER ANALYTES AND PROJECT SCREENING LEVELS**

CAS No.	Chemical	RSL TAP <sup>(1)</sup> (ug/L)	RISK BASIS	RSL TAP-ADJ <sup>(2)</sup> (ug/L)	MCL <sup>(3)</sup> (ug/L)	RIDEM GA GW OBJECTIVE <sup>(4)</sup> (ug/L)	RIDEM GB GW OBJECTIVE <sup>(4)</sup> (ug/L)	VISL <sup>(5)</sup> (ug/L)	RISK BASIS	VISL-ADJ <sup>(6)</sup> (ug/L)	Minimum Criterion (ug/L)	Minimum Criterion Reference (ug/L)	
TCL VOCs													
71-55-6	1,1,1-TRICHLOROETHANE	8000	N	800	200	200	3100	7400	N	740	200	MCL/GA-GW	
79-00-5	1,1,2-TRICHLOROETHANE	0.28	C	0.041	5	5	--	5.2	C	0.62	0.041	T-RSL	
79-34-5	1,1,2,2-TETRACHLOROETHANE	0.076	C	0.076	--	--	--	3.2	C	3.2	0.076	T-RSL	
76-13-1	1,1,2-TRICHLOROTRIFLUOROETHANE	55000	N	5500	--	--	--	1500	N	150	150	VISL	
75-34-3	1,1-DICHLOROETHANE	2.7	C	2.7	--	--	--	7.6	C	7.6	2.7	T-RSL	
75-35-4	1,1-DICHLOROETHENE	280	N	28	7	7	7	200	N	20	7	MCL/GA-GW/GB-GW	
95-50-1	1,2-DICHLOROBENZENE	300	N	30	600	600	--	2700	N	270	30	T-RSL	
107-06-2	1,2-DICHLOROETHANE	0.17	C	0.17	5	5	110	2.2	C	2.2	0.17	T-RSL	
87-61-6	1,2,3-TRICHLOROETHENE	7.0	N	0.70	--	--	--	--	--	--	0.70	T-RSL	
120-82-1	1,2,4-TRICHLOROETHENE	1.1	C	0.40	70	70	--	36	N	3.6	0.40	T-RSL	
96-12-8	1,2-DIBROMO-3-CHLOROPROPANE	0.00033	C	0.00033	0.2	0.2	2	0.028	C	0.028	0.00033	T-RSL	
106-93-4	1,2-DIBROMOETHANE	0.0075	C	0.0075	0.05	0.05	--	0.18	C	0.18	0.0075	T-RSL	
78-87-5	1,2-DICHLOROPROPANE	0.44	C	0.44	5	5	3000	2.4	C	2.4	0.44	T-RSL	
541-73-1	1,3-DICHLOROETHENE	--	--	--	--	600	--	--	--	--	600	GA-GW	
106-46-7	1,4-DICHLOROETHENE	0.48	C	0.48	75	75	--	2.6	C	2.6	0.48	T-RSL	
78-93-3	2-BUTANONE	5600	N	560	--	--	--	220000	N	22000	560	T-RSL	
581-78-6	2-HEXANONE	38	N	3.8	--	--	--	8200	N	820	3.8	T-RSL	
108-10-1	4-METHYL-2-PENTANONE	1200	N	120	--	--	--	550000	N	5500	120	T-RSL	
67-64-1	ACETONE	14000	N	1400	--	--	--	23000000	N	2300000	1400	T-RSL	
71-43-2	BENZENE	0.45	C	0.45	5	5	140	1.6	C	1.6	0.45	T-RSL	
74-97-5	BROMOCHLOROMETHANE	83	N	8.3	--	--	--	700	N	70	8.3	T-RSL	
75-27-4	BROMODICHLOROMETHANE	0.13	C	0.13	80	80	--	0.88	C	0.88	0.13	T-RSL	
75-25-2	BROMOFORM	9.2	C	9.2	80	80	--	--	--	--	9.2	T-RSL	
74-83-9	BROMOMETHANE	7.5	N	0.75	--	--	--	17	N	1.7	0.75	T-RSL	
75-15-0	CARBON DISULFIDE	810	N	81	--	--	--	1200	N	120	81	T-RSL	
56-23-5	CARBON TETRACHLORIDE	0.45	C	0.45	5	5	70	0.41	C	0.41	0.41	VISL	
108-90-7	CHLOROETHANE	78	N	7.8	100	100	3200	410	N	41	7.8	T-RSL	
75-00-3	CHLOROETHANE	21000	N	2100	--	--	--	23000	N	2300	2100	T-RSL	
67-66-3	CHLOROFORM	0.22	C	0.22	80	80	--	0.81	C	0.81	0.22	T-RSL	
74-87-3	CHLOROMETHANE	190	N	19	--	--	--	260	N	26	19	T-RSL	
156-59-2	CIS-1,2-DICHLOROETHENE	36	N	3.6	70	70	2400	--	--	--	3.6	T-RSL	
10061-01-5	CIS-1,3-DICHLOROPROPENE	0.47	C <sup>(B)</sup>	0.47	--	--	--	4.8	C <sup>(B)</sup>	4.8	0.47	T-RSL	
110-82-7	CYCLOHEXANE	13000	N	1300	--	--	--	1000	N	100	100	VISL	
124-48-1	CHLORODIBROMOMETHANE	0.17	C	0.17	80	80	--	3.2	C	3.2	0.17	T-RSL	
75-71-8	DICHLORODIFLUOROMETHANE	200	N	20	--	--	--	7.4	N	0.74	0.74	VISL	
100-41-4	ETHYLBENZENE	1.5	C	1.5	700	700	1600	3.5	C	3.5	1.5	T-RSL	
98-82-8	ISOPROPYLBENZENE	450	N	45	--	--	--	890	N	89	45	T-RSL	
79-20-9	METHYL ACETATE	20000	N	2000	--	--	--	--	--	--	2000	T-RSL	
1634-04-4	METHYL TERT-BUTYL ETHER (MTBE)	14	C	14	--	40	5000	450	C	450	14	T-RSL	
108-87-2	METHYL CYCLOHEXANE	--	--	--	--	--	--	--	--	--	--	--	
75-09-2	METHYLENE CHLORIDE	11	C	11	5	5	--	760	C	470	5	MCL/GA-GW	
100-42-5	STYRENE	1200	N	120	100	100	2200	9300	N	930	100	MCL/GA-GW	
127-18-4	TETRACHLOROETHENE	11	C	4.1	5	5	150	15	C	5.8	4.1	T-RSL	
108-88-3	TOLUENE	1100	N	110	1000	1000	1700	19000	N	1900	110	T-RSL	
95-47-6	O-XYLENE	190	N	19	--	--	--	--	--	--	19	T-RSL	
179601-23-1	M+P-XYLENES	190	N	19	--	--	--	--	--	--	19	T-RSL	
156-60-5	TRANS-1,2-DICHLOROETHENE	360	N	36	100	100	2800	--	--	--	36	T-RSL	
10061-02-6	TRANS-1,3-DICHLOROPROPENE	0.47	C <sup>(B)</sup>	0.47	--	--	--	4.8	C <sup>(B)</sup>	4.8	0.47	T-RSL	
79-01-6	TRICHLOROETHENE	0.49	C	0.28	5	5	540	1.2	C	0.52	0.28	T-RSL	
75-69-4	TRICHLOROFLUOROMETHANE	1100	N	110	--	--	--	180	N	18	18	VISL	
75-01-4	VINYL CHLORIDE	0.019	C	0.019	2	2	2	0.15	C	0.15	0.019	T-RSL	
1330-20-7	XYLENES (TOTAL)	190	N	19	10000	10000	--	490	N	49	19	T-RSL	
SVOCs													
92-52-4	1,1'-BIPHENYL	0.83	N	0.083	--	--	--	33	N	3.3	0.083	T-RSL	
99-85-0	1,3-DINITROBENZENE	2.0	N	0.20	--	--	--	--	--	--	0.20	T-RSL	
123-91-1	1,4-DIOXANE	0.78	C	0.78	--	--	--	--	--	--	0.78	T-RSL	
108-60-1	2,2'-OXYBIS(1-CHLOROPROPANE)	0.36	C	0.36	--	--	--	93	C	93	0.36	T-RSL	
95-95-4	2,4,5-TRICHLOROPHENOL	1200	N	120	--	--	--	--	--	--	120	T-RSL	
88-06-2	2,4,6-TRICHLOROPHENOL	4.0	C	1.2	--	--	--	--	--	--	1.2	T-RSL	
120-83-2	2,4-DICHLOROPHENOL	46	N	4.6	--	--	--	--	--	--	4.6	T-RSL	
105-67-9	2,4-DIMETHYLPHENOL	360	N	36	--	--	--	--	--	--	36	T-RSL	
51-28-5	2,4-DINITROPHENOL	39	N	3.9	--	--	--	--	--	--	3.9	T-RSL	
121-14-2	2,4-DINITROTOLUENE	0.24	C	0.24	--	--	--	--	--	--	0.24	T-RSL	
606-20-2	2,6-DINITROTOLUENE	0.048	C	0.048	--	--	--	--	--	--	0.048	T-RSL	
91-58-7	2-CHLORONAPHTHALENE	750	N	75	--	--	--	--	--	--	75	T-RSL	
95-57-8	2-CHLOROPHENOL	91	N	9.1	--	--	--	--	--	--	9.1	T-RSL	
95-48-7	2-METHYLPHENOL (O-CRESOL)	930	N	93	--	--	--	--	--	--	93	T-RSL	
88-74-4	2-NITROANILINE	190	N	19	--	--	--	--	--	--	19	T-RSL	
88-75-5	2-NITROPHENOL	--	--	--	--	--	--	--	--	--	--	--	
91-94-1	3,3'-DICHLOROENZIDINE	0.12	C	0.12	--	--	--	--	--	--	0.12	T-RSL	
108-39-4	3-METHYLPHENOL (M-CRESOL)	930	N	93	--	--	--	--	--	--	93	T-RSL	
99-09-2	3-NITROANILINE	3.8	C <sup>(B)</sup>	3.8	--	--	--	--	--	--	3.8	T-RSL	
534-52-1	4,6-DINITRO-2-METHYLPHENOL	1.5	N	0.15	--	--	--	--	--	--	0.15	T-RSL	
101-55-3	4-BROMOPHENYL PHENYL ETHER	--	--	--	--	--	--	--	--	--	--	--	
59-50-7	4-CHLORO-3-METHYL PHENOL	1400	N	140	--	--	--	--	--	--	140	T-RSL	
106-47-8	4-CHLOROANALINE	0.36	C	0.36	--	--	--	--	--	--	0.36	T-RSL	
7005-72-3	4-CHLOROPHENYL PHENYL ETHER	--	--	--	--	--	--	--	--	--	--	--	
106-44-5	4-METHYLPHENOL (P-CRESOL)	1900	N	190	--	--	--	--	--	--	190	T-RSL	
100-01-6	4-NITROANILINE	3.8	C	3.8	--	--	--	--	--	--	3.8	T-RSL	
100-02-7	4-NITROPHENOL	--	--	--	--	--	--	--	--	--	--	--	
98-86-2	ACETOPHENONE	1900	N	190	--	--	--	--	--	--	190	T-RSL	
1912-24-9	ATRAZINE	0.30	C	0.30	3	--	--	--	--	--	0.30	T-RSL	
100-52-7	BENZALDEHYDE	1900	N	190	--	--	--	--	--	--	190	T-RSL	
111-91-1	BIS(2-CHLOROETHOXY)METHANE	59	N	5.9	--	--	--	--	--	--	5.9	T-RSL	
111-44-4	BIS(2-CHLOROETHYL)ETHER	0.014	C	0.014	--	--	--	12	C	12	0.014	T-RSL	
117-81-7	BIS(2-ETHYLHEXYL)PHTHALATE	5.6	C	5.6	6	6	--	--	--	--	5.6	T-RSL	
85-68-7	BUTYL BENZYL PHTHALATE	16	C	16	--	--	--	--	--	--	16	T-RSL	
105-60-2	CARBOANTHAM	9900	N	990	--	--	--	--	--	--	990	T-RSL	
86-74-8	CARBAZOLE	--	--	--	--	--	--	--	--	--	--	--	
132-64-9	DIBENZOFURAN	7.9	N	0.79	--	--	--	--	--	--	0.79	T-RSL	
84-66-2	DIETHYL PHTHALATE	15000	N	1500	--	--	--	--	--	--	1500	T-RSL	
131-11-3	DIMETHYL PHTHALATE	--	--	--	--	--	--	--	--	--	--	--	
84-74-2	DI-N-BUTYL PHTHALATE	900	N	90	--	--	--	--	--	--	90	T-RSL	
117-84-0	DI-N-OCTYL PHTHALATE	200	N	20	--	--	--	--	--	--	20	T-RSL	
118-74-1	HEXACHLOROETHANE	0.049	C	0.049	1	1	--	--	--	--	0.049	T-RSL	
87-68-3	HEXACHLOROBUTADIENE	0.30	C	0.30	--	--	--	--	--	--	0.30	T-RSL	
77-47-4	HEXACHLOROOCYCLOPENTADIENE	31	N	3.1	50	--	--	--	--	--	3.1	T-RSL	
67-72-1	HEXACHLOROETHANE	0.90	C	0.69	--	--	--	--	--	--	0.69	T-RSL	
78-59-1	ISOPHORONE	78	C	78	--	--	--	--	--	--	78	T-RSL	
98-95-3	NITROBENZENE	0.14	C	0.14	--	--	--	72	C	72	0.14	T-RSL	
621-64-7	N-NITROSODI-N-PROPYLAMINE	0.011	C	0.011	--	--	--	--	--	--	0.011	T-RSL	
86-30-6	N-NITROSODIPHENYLAMINE	12	C	12	--	--	--	--	--	--	12	T-RSL	
87-86-5	PENTACHLOROPHENOL	0.040	C	0.040	1	1	--	--	--	--	0.040	T-RSL	
108-95-2	PHENOL	5800	N	580	--	--	--	--	--	--	580	T-RSL	

TABLE F-2

## GROUNDWATER ANALYTES AND PROJECT SCREENING LEVELS

CAS No.	Chemical	RSL TAP <sup>(1)</sup> (ug/L)	RISK BASIS	RSL TAP-ADJ <sup>(2)</sup> (ug/L)	MCL <sup>(3)</sup> (ug/L)	RIDEM GA GW OBJECTIVE <sup>(4)</sup> (ug/L)	RIDEM GB GW OBJECTIVE <sup>(4)</sup> (ug/L)	VISL <sup>(6)</sup> (ug/L)	RISK BASIS	VISL-ADJ <sup>(6)</sup> (ug/L)	Minimum Criterion (ug/L)	Minimum Criterion Reference (ug/L)
<b>PAHs</b>												
91-57-6	2-METHYLNAPHTHALENE	36	N	3.6	--	--	--	--	--	--	3.6	T-RSL
83-32-9	ACENAPHTHENE	530	N	53	--	--	--	--	--	--	53	T-RSL
208-96-8	ACENAPHTHYLENE	530	N <sup>(10)</sup>	53 <sup>(10)</sup>	--	--	--	--	--	--	53	T-RSL
120-12-7	ANTHRACENE	1800	N	180	--	--	--	--	--	--	180	T-RSL
56-55-3	BENZO(A)ANTHRACENE	0.034	C	0.034	--	--	--	--	--	--	0.034	T-RSL
50-32-8	BENZO(A)PYRENE	0.0034	C	0.0034	0.2	0.2	--	--	--	--	0.0034	T-RSL
205-99-2	BENZO(B)FLUORANTHENE	0.034	C	0.034	--	--	--	--	--	--	0.034	T-RSL
191-24-2	BENZO(G,H)PERYLENE	120	N <sup>(11)</sup>	12 <sup>(11)</sup>	--	--	--	--	--	--	12	T-RSL
207-08-9	BENZO(K)FLUORANTHENE	0.34	C	0.34	--	--	--	--	--	--	0.34	T-RSL
218-01-9	CHRYSENE	3.4	C	3.4	--	--	--	--	--	--	3.4	T-RSL
53-70-3	DIBENZO(A,H)ANTHRACENE	0.0034	C	0.0034	--	--	--	--	--	--	0.0034	T-RSL
206-44-0	FLUORANTHENE	800	N	80	--	--	--	--	--	--	80	T-RSL
86-73-7	FLUORENE	290	N	29	--	--	--	--	--	--	29	T-RSL
193-39-5	INDENO(1,2,3-C)DIPYRENE	0.034	C	0.034	--	--	--	--	--	--	0.034	T-RSL
91-20-3	NAPHTHALENE	0.17	C	0.17	--	100	--	4.6	C	4.6	0.17	T-RSL
85-01-8	PHENANTHRENE	120	N <sup>(11)</sup>	12 <sup>(11)</sup>	--	--	--	--	--	--	12	T-RSL
129-00-0	PYRENE	120	N	12	--	--	--	--	--	--	12	T-RSL
<b>PCBs</b>												
12674-11-2	AROCOLOR-1016	1.1	C	0.14 <sup>(7)</sup>	--	0.5	--	--	--	--	0.14	T-RSL
11104-28-2	AROCOLOR-1221	0.0046	C	0.0046	--	0.5	--	0.16	C	0.16	0.0046	T-RSL
11141-16-5	AROCOLOR-1232	0.0046	C	0.0046	--	0.5	--	0.16	C	0.16	0.0046	T-RSL
53469-21-9	AROCOLOR-1242	0.039	C	0.039	--	0.5	--	--	--	--	0.039	T-RSL
12672-29-6	AROCOLOR-1248	0.039	C	0.039	--	0.5	--	--	--	--	0.039	T-RSL
11097-69-1	AROCOLOR-1254	0.039	C	0.039	--	0.5	--	--	--	--	0.039	T-RSL
11096-82-5	AROCOLOR-1260	0.039	C	0.039	--	0.5	--	--	--	--	0.039	T-RSL
<b>Pesticides</b>												
72-54-8	4,4'-DDD	0.031	C	0.031	--	--	--	--	--	--	0.031	T-RSL
72-55-9	4,4'-DDE	0.23	C	0.23	--	--	--	--	--	--	0.23	T-RSL
50-29-3	4,4'-DDT	0.23	C	0.23	--	--	--	--	--	--	0.23	T-RSL
309-00-2	ALDRIN	0.0046	C	0.0046	--	--	--	--	--	--	0.0046	T-RSL
319-84-6	ALPHA-BHC	0.0071	C	0.0071	--	--	--	--	--	--	0.0071	T-RSL
5103-71-9	ALPHA-CHLORDANE	0.22	C <sup>(12)</sup>	0.22 <sup>(12)</sup>	--	2	--	--	--	--	0.22	T-RSL
319-85-7	BETA-BHC	0.025	C	0.025	--	--	--	--	--	--	0.025	T-RSL
319-86-8	DELTA-BHC	0.0071	C <sup>(13)</sup>	0.0071	--	--	--	--	--	--	0.0071	T-RSL
60-57-1	DIELDRIN	0.0017	C	0.0017	--	--	--	--	--	--	0.0017	T-RSL
959-98-8	ENDOSULFAN I	100	N <sup>(14)</sup>	10 <sup>(14)</sup>	--	--	--	--	--	--	10	T-RSL
33213-65-9	ENDOSULFAN II	100	N <sup>(14)</sup>	10 <sup>(14)</sup>	--	--	--	--	--	--	10	T-RSL
1031-07-8	ENDOSULFAN SULFATE	100	N <sup>(14)</sup>	10 <sup>(14)</sup>	--	--	--	--	--	--	10	T-RSL
72-20-8	ENDRIN	2.3	N	0.23	2	--	--	--	--	--	0.23	T-RSL
7421-93-4	ENDRIN ALDEHYDE	2.3	N <sup>(15)</sup>	0.23 <sup>(15)</sup>	--	--	--	--	--	--	0.23	T-RSL
53494-70-5	ENDRIN KETONE	2.3	N <sup>(15)</sup>	0.23 <sup>(15)</sup>	--	--	--	--	--	--	0.23	T-RSL
58-89-9	GAMMA-BHC (LINDANE)	0.041	C	0.041	0.2	--	--	--	--	--	0.041	T-RSL
5103-74-2	GAMMA-CHLORDANE	0.22	C <sup>(12)</sup>	0.22 <sup>(12)</sup>	--	2	--	--	--	--	0.22	T-RSL
76-44-8	HEPTACHLOR	0.0020	C	0.0020	0.4	--	--	--	--	--	0.0020	T-RSL
1024-57-3	HEPTACHLOR EPOXIDE	0.0038	C	0.0038	0.2	--	--	--	--	--	0.0038	T-RSL
72-43-5	METHOXYCHLOR	37	N	3.7	40	--	--	--	--	--	3.7	T-RSL
8001-35-2	TOXAPHENE	0.015	C	0.015	3	--	--	--	--	--	0.015	T-RSL
<b>TAL Metals</b>												
7429-90-5	ALUMINUM	20000	N	2000	--	--	--	--	--	--	2000	T-RSL
7440-36-0	ANTIMONY	7.8	N	0.78	6	6	--	--	--	--	0.78	T-RSL
7440-38-2	ARSENIC	0.052	C	0.052	10	10	--	--	--	--	0.052	T-RSL
7440-39-3	BARIUM	3800	N	380	2000	2000	--	--	--	--	380	T-RSL
7440-41-7	BERYLLIUM	25	N	2.5	4	4	--	--	--	--	2.5	T-RSL
7440-43-9	CADMIUM	9.2	N	0.92	5	5	--	--	--	--	0.92	T-RSL
7440-70-2	CALCIUM	--	--	--	--	--	--	--	--	--	--	--
7440-47-3	CHROMIUM	0.035	C <sup>(16)</sup>	0.035 <sup>(16)</sup>	100	100	--	--	--	--	0.035	T-RSL
7440-48-4	COBALT	6.0	N	0.60	--	--	--	--	--	--	0.60	T-RSL
7440-50-8	COPPER	800	N	80	1300	--	--	--	--	--	80	T-RSL
7439-89-6	IRON	14000	N	1400	--	--	--	--	--	--	1400	T-RSL
7439-92-1	LEAD	15	N	1.5	15	15	--	--	--	--	1.5	T-RSL
7439-97-6	MERCURY	0.63	N <sup>(17)</sup>	0.063 <sup>(17)</sup>	2	2	--	--	--	--	0.063	T-RSL
7439-95-4	MAGNESIUM	--	--	--	--	--	--	--	--	--	--	--
7439-96-5	MANGANESE	430	N	43	--	--	--	--	--	--	43	T-RSL
7440-02-0	NICKEL	390	N	39	--	100	--	--	--	--	39	T-RSL
7440-09-7	POTASSIUM	--	--	--	--	--	--	--	--	--	--	--
7782-49-2	SELENIUM	100	N	10	50	50	--	--	--	--	10	T-RSL
7440-22-4	SILVER	94	N	9.4	--	--	--	--	--	--	9.4	T-RSL
7440-23-5	SODIUM	--	--	--	--	--	--	--	--	--	--	--
7440-28-0	THALLIUM	0.20	N	0.020	2	2	--	--	--	--	0.020	T-RSL
7440-62-2	VANADIUM	86	N	8.6	--	--	--	--	--	--	8.6	T-RSL
7440-66-6	ZINC	6000	N	600	--	--	--	--	--	--	600	T-RSL
<b>PETROLEUM HYDROCARBONS</b>												
--	TPH-GRO (MTBE through naphthalene)	--	--	--	--	--	--	--	--	--	--	--
--	TPH-DRO (C9-C40)	--	--	--	--	--	--	--	--	--	--	--

1 - United States Environmental Protection Agency (USEPA) Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites, May 2014.

Tap water screening levels are based on a lifetime cancer risk of 1E-06 for carcinogens (C) or a hazard quotient (HQ) of 1 for noncarcinogens (N).

2 - RSLs for noncarcinogens were adjusted (i.e., divided by 10) to represent an HQ of 0.1.

3 - Federal Maximum Contaminant Levels (MCLs), 2012 Edition of the Drinking Water Standards and Health Advisories. Office of Water, Washington, D.C. EPA 822-S-12-001. April.

4 - Rhode Island Department of Environmental Management (RIDEM), DEM-DSR-01-93, November 2011.

5 - Calculated using USEPA's Vapor Intrusion Screening Level (VISL) calculator Version 3.3, May 2014 RSLs. Values correspond to a target cancer risk level of 1E-06 for carcinogens (C) or hazard quotient (HQ) of 0.1 for noncarcinogens (N) and an attenuation factor of 0.001.

6 - VISLs for noncarcinogens were adjusted (i.e., divided by 10) to represent an HQ of 0.1.

7 - One-tenth the noncarcinogenic screening level is less than the carcinogenic screening level; therefore, the noncarcinogenic screening level is presented.

8 - The value is for 1,3-dichloropropene.

9 - The value is for 4-nitroaniline.

10 - The value is for acenaphthene.

11 - The value is for pyrene.

12 - The value is for chlordane.

13 - The value is for alpha-BHC.

14 - The value is for endosulfan.

15 - The value is for endrin.

16 - The value is for hexavalent chromium.

17 - The value is for mercury (elemental).